

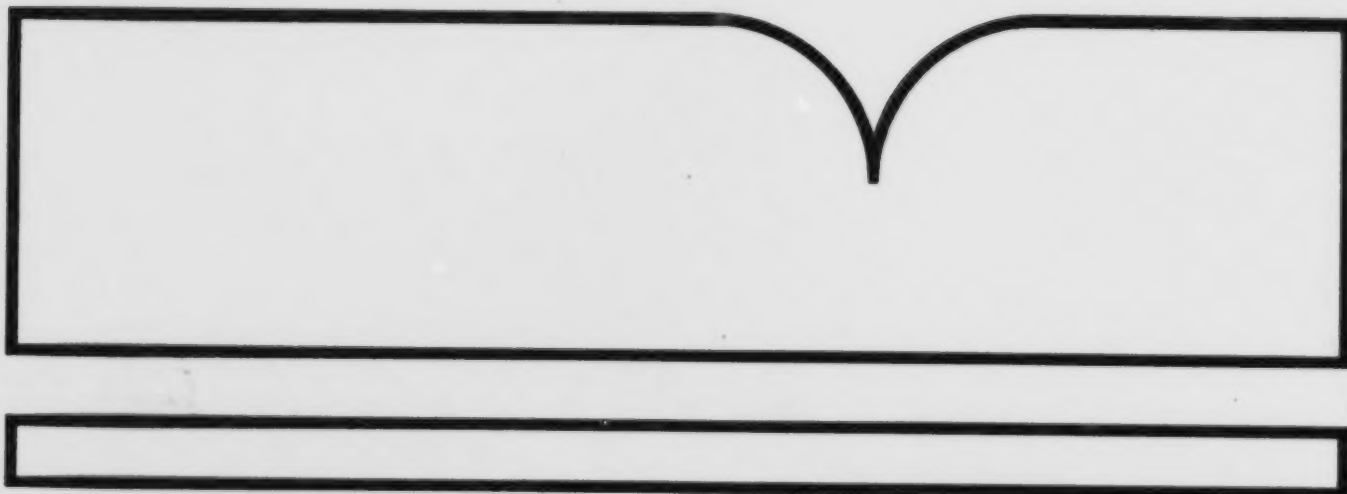
Economic Impact Analysis, RCRA (Resource
Conservation and Recovery Act) Interim
Status Standards. Volume I

Arthur D. Little, Inc.
Cambridge, MA

Prepared for

Environmental Protection Agency
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ECONOMIC IMPACT ANALYSIS
RCRA INTERIM STATUS STANDARDS

Volume - I

2

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PREFACE*

This Economic Impact Analysis (EIA) of Phase I of the Resource Conservation and Recovery Act (RCRA) Subtitle C hazardous waste program analyzes the costs and impacts of regulations for generators; transporters; and treaters, storers, and disposers under the Interim Status Standards (ISS). It supersedes the preliminary final Economic Impact Analysis EPA prepared to support the May 19, 1980 regulations.

SCOPE OF THE ANALYSIS

This report analyzes the hazardous waste regulations EPA promulgated or proposed through November 1980. Since then, EPA has continued to modify the regulations. Without additional analysis, however, EPA cannot determine the precise changes in the costs and impacts or the overall effect these modifications cause. But because these changes are significant, EPA can report whether the ISS compliance costs and resultant impacts will increase or decrease.

The analysis includes only the hazardous waste generated by 109 segments of 22 major industries. Although the impact of RCRA falls most heavily on these industry segments, the program affects a greater number of industries and encompasses larger quantities of waste than this report indicates.

This report analyzes regulatory costs and impacts based on a firm's cash flow and profitability ("private costs") rather than on resource costs to society ("social costs"). Although measuring these "private costs" is useful in predicting how firms will respond to the regulation, resource costs or "social costs" serve as the proper cost basis for benefit/cost analysis. Ultimately, EPA plans to measure both private and social costs for the entire set of RCRA regulations.

The following sections summarize how EPA expects various regulatory changes not addressed in this report to affect the costs and impacts of the Interim Status Standards.

CLOSURE AND POST-CLOSURE FINANCIAL RESPONSIBILITY COSTS AND IMPACTS WILL DECREASE

Financial responsibility requirements will cost less than this report indicates. The most significant changes will occur in the following areas:

- Facilities that can pass the financial test or those able to obtain third-party financial guarantees for their closure and post-closure obligations will experience significant cost savings over the current estimates, which assume that all firms use trust funds. Similarly, letters of credit and insurance for closure and post-closure will lower costs significantly. Although some firms will continue using trust funds

*Prepared by EPA

because the lower-cost options are not available, a large portion of facilities will use mechanisms less expensive than trust funds.

- The analysis does not fully consider the tax implications of the trust fund. Firms that use these funds cannot deduct their deposits as business expenditures, and will also pay taxes on the accrued interest so the cost of a trust fund will be somewhat higher than that which appears in the report.

TREATMENT AND STORAGE REGULATIONS WILL INCREASE COSTS

This report contains an analysis of RCRA ISS costs on only the most widely employed and generally most costly hazardous waste management practices. These include: incinerators, landfills, land treatment, surface impoundments, and tanks used for treatment or storage prior to off-site disposal. In addition, the ISS regulate waste piles; thermal treatment; chemical, physical, and biological treatment; and the use and management of containers. The EIA does not include the costs for these practices.

UNDERGROUND INJECTION RCRA COSTS WILL DECLINE OVER TIME

Underground injection of hazardous waste falls under the jurisdiction of both RCRA and the Safe Drinking Water Act (SDWA). The SDWA created an Underground Injection Control (UIC) program that requires each state to implement standards that protect sources of drinking water from contamination by the injection of substances into wells. Because the UIC program does not provide for the equivalent of an interim status period, EPA concluded that the underground injection of hazardous waste is subject to the RCRA ISS in each state that has not implemented its own UIC program. The EIA does not contain costs or impacts incurred under RCRA by owners or operators of underground injection wells.

DELISTING WASTES DROPS INDUSTRIES FROM THE SYSTEM

Between May 19, 1980 and the publication date of this report, EPA significantly altered the list of hazardous wastes that appears in Part 261 of the regulations. As a result of Congressional action, public comments, and its own research, the Agency deleted several listed wastes and waste streams, although any solid waste that possesses the characteristics of toxicity, ignitability, reactivity, or corrosivity will remain in the hazardous waste management system. The industries whose compliance costs and impacts will decrease most significantly are the following:

- *Leather Tanning and Finishing.* On October 30, 1980, EPA suspended its listing for waste streams that were listed solely because they contained hexavalent chromium. This action removes most leather tanning and finishing wastes from the RCRA hazardous waste man-

agement system. Consequently, a leather tanner or finisher incurs compliance costs under RCRA only if its wastes fail one or more of the tests for hazardous waste characteristics. EPA believes that virtually all leather tanning and finishing wastes are exempt from RCRA control, and that it is unlikely that the industry will incur a significant portion, if any, of the \$23.7 million in annualized compliance costs that this report predicts. The Agency believes that its action allows the industry to avert the four plant closings and 220 job losses projected by the analysis.

- *Paint and Allied Products.* On January 16, 1981, EPA temporarily suspended its listing of paint manufacturing solvents, cleaning wastes, and sludges. This action exempts all wastes from the paint and allied products industry from control under RCRA, with the exception of an unknown quantity of wastes that might fail the hazardous characteristics tests. If these wastes are not relisted, the paint and allied products industry will incur little, if any, of the \$21.6 million in annualized compliance costs that appear in this report, and it is unlikely that the industry will experience plant closures or job losses.
- *Textiles.* EPA indicated on July 16, 1980 that it would temporarily defer listing wastewater treatment sludges from the woven fabric dyeing and finishing industry as hazardous wastes. This action exempts all textile wastes from control under RCRA, with the exception of an unknown quantity of spent solvents that might fail the hazardous characteristics tests. EPA is unable, at this time, to determine the quantity of textile wastes that will fail the test for hazardous characteristics. The Agency believes, however, that its decision to defer listing substantially decreases the quantity of textile wastes subject to the RCRA management system. It now appears likely that the industry will incur only a small portion of the \$21.7 million in annualized compliance costs projected by the analysis, and that it will suffer far fewer than the 17 projected plant closures and 1940 job losses. The change in impacts on the textile industry is difficult to predict without analysis, however, because of the number of production processes and waste treatment and storage practices in the industry.
- *Nonferrous Metal Smelting and Refining.* On November 19, 1980, EPA suspended its final listings of most of the hazardous wastes generated by the nonferrous metal smelting and refining industry. The Agency took this action in response to Congressional amendments to RCRA that prohibit EPA from regulating wastes from the extraction, beneficiation, and processing of ores and minerals. EPA interprets these amendments broadly and delisted all wastes from primary metal production, leaving only secondary lead emission control sludge and leaching solution as listed wastes. The secondary lead

segment accounts for only \$1.4 million of the \$13.1 million total annualized compliance cost projected by the analysis. Even if characteristic wastes bring some secondary production segments into the RCRA system, the industry will probably not suffer any plant closures or job losses.

I. EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) has recently promulgated regulations for managing hazardous waste generation, transportation, and treatment, storage, and disposal. These regulations implement portions of Subtitle C of the Resource Conservation and Recovery Act of 1976 (RCRA). This report presents the incremental compliance costs and resultant economic impacts of Sections 3001, 3002, 3003, 3004 (the Interim Status Standards, hereafter referred to as ISS), and 3005 of RCRA as promulgated or proposed through November 1980. EPA has prepared this report as part of its policy implementing Executive Order 12044 for conducting impact assessments of its proposed regulatory actions.

This report covers 22 U.S. industries that generated approximately 26 million metric tons of hazardous waste as of 1978. The analysis does not include all wastes generated by these industries, nor does it encompass all industrial waste generators. In addition, the costs and impacts of rules proposed or modified after November 1980 do not appear in this report.

The study is organized into six major parts:

- Chapter II presents the introduction,
- Chapter III presents the background of the RCRA ISS regulations and resultant compliance activities,
- Chapter IV presents information on waste generators and management practices,
- Chapter V develops the cost and economic impact methodology,
- Chapter VI presents the compliance costs of the ISS regulations and the economic impacts for 22 generator industries, and
- Chapter VII discusses the limits to the analysis.

Appendices A through I provide supporting data and details of the analysis.

The remainder of this Executive Summary highlights the study's major findings and conclusions.

A. ECONOMIC IMPACT

1. The ISS regulations compliance cost will impose some costs on most hazardous waste generators.
 - The total annualized incremental cost of compliance with ISS is \$665 million per year (pre-tax) for the 22 industries studied, representing

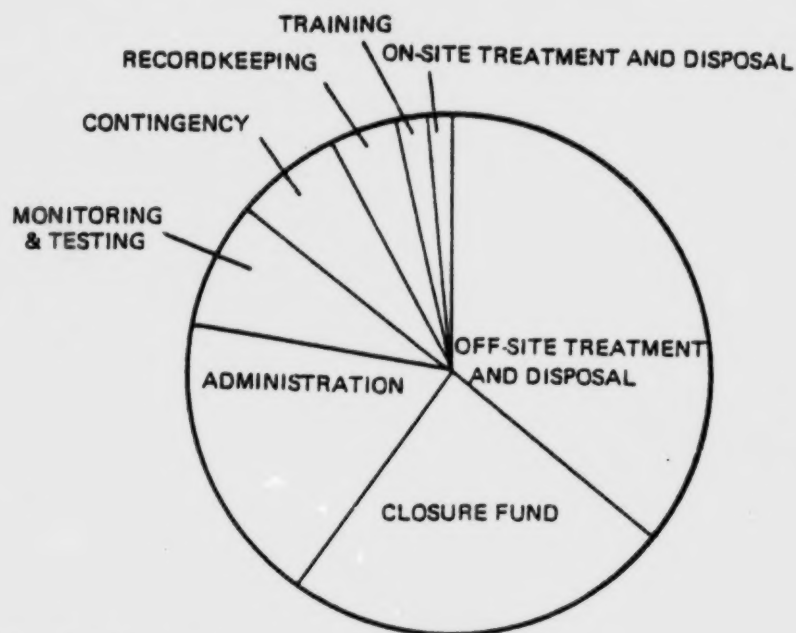
only about 0.34% of the inflation-adjusted aggregate value added of those industries.* Of this cost, \$255 million (38%) is to pay higher prices for off-site waste disposal (see Figure I-1). Most of this increase, about two-thirds, is to cover higher testing costs. Of the annualized costs, \$164 million (25%) is for non-tax-deductible closure and post-closure fund contributions.

- Total expenditures in the first year of the regulation will be \$840 million. Of this, \$79 million is for the first of 20 annual contributions to the closure funds, \$167 million is for capital expenditures, and \$352 million is for one-time expenses, such as waste stream testing. (See Figure I-2 for relationship of these components.)
- The incremental annualized costs average \$36 per metric ton of hazardous waste and \$15,300 per generator plant. Generators in several industries exceed these averages. The annualized costs for petroleum refiners are \$41 per metric ton and \$277,000 per plant. Chemical wholesalers average \$1200 per metric ton per year but only \$1700 per plant. The inorganic chemical industry has the second highest plant cost, \$174,000, but a very low per-ton cost, \$6 per metric ton, reflecting the high volume of waste per plant in this industry.
- The annualized cost per year averages approximately \$30 million per industry (see Table I-1). The largest costs fall on agricultural services (pesticides application), with \$141 million per year in annualized compliance costs. Four other industries will have annualized compliance costs of more than \$30 million per year.
- On average, waste generating industries face costs from ISS of less than 0.5% of their adjusted value added (see Table I-1). As whole industries, agricultural services has the highest percent (6.54%), followed by petroleum rerefining (6.06%). Individual industry segments will have significantly higher impacts (see Table I-2) than the whole industries. Captive electroplating shops have the highest percent (16.2%).

2. RCRA ISS may close plants in 13 of the 22 industries studied.

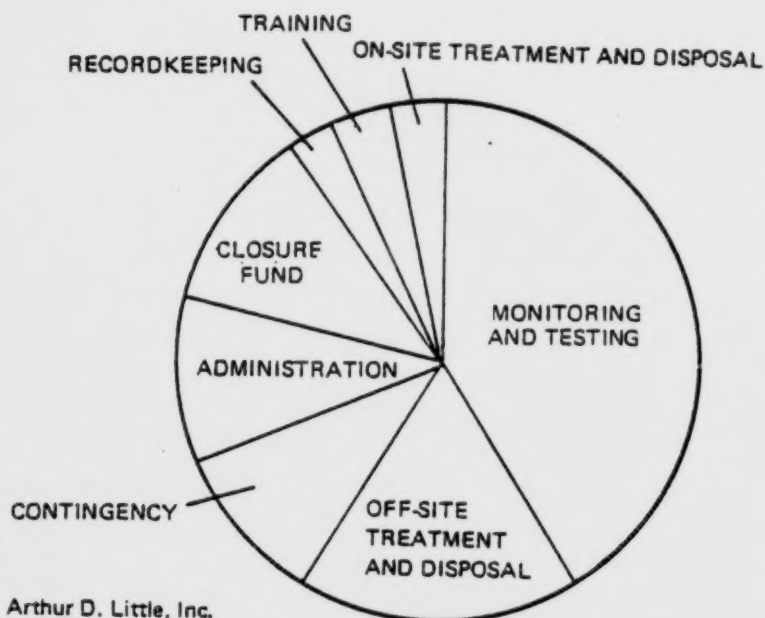
- EPA expects plant closings and job losses in segments of 13 industries (Table I-3).
- Two primary zinc plant closures in the nonferrous metal smelting and refining industry could result in 1200 job losses. Forty-eight job shop closures in the electroplating and metal finishing industry are expected to result in roughly 1340 job losses.

*To account for inflation and for year-to-year variations in expenses, the report contains a set of annualized cost-of-compliance figures in addition to costs expressed in 1978 dollars. Twenty years of payments of the annualized amount would have the same net present value as would the actual costs, including inflation, over the same period. Similarly, an adjusted figure for value added accounts for inflation over the twenty years.



Source: Arthur D. Little, Inc.

FIGURE 1-1 ANNUALIZED INCREMENTAL COST OF COMPLIANCE BY COMPONENT



Source: Arthur D. Little, Inc.

FIGURE 1-2 FIRST-YEAR INCREMENTAL COST OF COMPLIANCE BY COMPONENT

TABLE I-1
INCREMENTAL ISS COMPLIANCE COST BY INDUSTRY
(million 1978 \$)

Industry	Annualized Cost ^a	Annualized Cost as a Percent of Adjusted Value Added
Agricultural Services	140.7	6.54
Electroplating and Metal Finishing	115.8	0.21
Petroleum Refining	79.0	0.31
Electronic Components	48.0	0.24
Ferrous Metal Smelting and Refining	36.4	0.31
Pesticides	29.7	0.64
Plastic Materials, Synthetic Rubbers, and Synthetic Fibers	28.9	0.69
Special Machinery Manufacturing	28.3	—
Leather Tanning and Finishing	23.7	3.85
Textile Manufacturing	21.7	0.25
Paint and Allied Products	21.6	0.35
Inorganic Chemicals (partial)	19.3	1.41
Nonferrous Metal Smelting and Refining	13.1	0.71
Battery Manufacturing	10.7	0.78
Rubber Products	9.8	0.06
Pharmaceuticals	8.4	0.05
Organic Chemicals (partial)	7.3	0.46
Commercial Explosives	6.9	0.88
Chemical Wholesaling	5.8	0.02
Wood Preserving	3.7	0.56
Petroleum Rerefining	2.8	6.06
Drum Reconditioning	2.8	0.52
Total	664.7 ^b	

a. The annualized cost is a 20-year annuity whose present value equals the present value of 20 years of uneven ISS compliance costs.

b. Column does not add to total because of rounding.

Source: Arthur D. Little, Inc., estimates.

3. Exemption from much of the ISS regulatory requirement reduces the impact on plants generating less than 1000 kg/month (12 MT/yr) of waste (small waste generators).

- Small waste generators are not required to conduct recordkeeping, reporting, or manifest activities; they must only test their waste and ensure that it is delivered to an EPA- or state-approved facility that can handle municipal or industrial wastes. This exemption saves the small waste generators a total of \$149 million per year.

TABLE I-2

**TEN HIGHEST INDUSTRY SEGMENT RATIOS OF ANNUALIZED ISS COMPLIANCE
COSTS TO ADJUSTED VALUE ADDED**

Industry Segment ^a	Annualized Cost/ Adjusted Value Added (%)
Electroplating: Captive — Indirect	16.2
Leather Tanning and Finishing: Retan — Wet Finish	14.1
Leather Tanning and Finishing: Chrome Tan, Save Hair	6.9
Plastics: Phenolic Resins	6.6
Agricultural Services	6.5
Petroleum Rerefining	6.1
Leather Tanning and Finishing: No Beamhouse	4.5
Leather Tanning and Finishing: Through-The-Blue	4.0
Leather Tanning and Finishing: Chrome Tan — Pulp Hair	3.5
Inorganic Chemicals: Chrome Pigments	2.0

a. The segments refer to different products or production methods.

Source: Arthur D. Little, Inc., estimates.

- Compliance costs for small waste generators under the exemptions are:

Total Annualized Cost	\$91.0 million
Annualized Cost per Plant	\$4270
Annualized Cost per MT	\$1017
Annualized Cost as Percent of Adjusted Value Added	0.41%

- If all ISS requirements were applied to small waste generators, the costs would be:

Total Annualized Cost	\$240 million
Annualized Cost per Plant	\$11,324
Annualized Cost per MT	\$2700
Annualized Cost as Percent of Adjusted Value Added	1.1%

4. Since most compliance costs do not vary with the waste quantity, the most severe economic impact is on "small" plants.

- The closure fund has the biggest impact on small plants with on-site disposal, especially those with surface impoundments.

TABLE I-3

INDUSTRY SEGMENTS WITH SIGNIFICANT POTENTIAL FOR PLANT CLOSURES

Industry Segment	Number of Plants	Plant Closures	Job Losses	Price Increases
Agricultural Services	22,700	Likely	Probable	Likely
Textile Manufacturing				
Knit Hosiery	161	6	1,370	None
Woven Fabric Finish-Simple	206	10	410	None
Stock & Yarn Finishing	218	1	160	None
Inorganic Chemicals				
Chlor-Alkali Diaphragm Cell Process: Small Plants	12	2 ^a	46	2.1 ^b
Chlor-Alkali Mercury Cell Process: Small Plants	11	9 ^a	153	11.6 ^b
Titanium Dioxide Sulfate Process: Small Plants	2	2	562	4.2 ^b
Plastic Materials, Synthetic Rubbers, and Synthetic Fibers				
Phenolic Resins	120	Probable	Possible	Likely
Pharmaceuticals				
Medicinals and Botanicals	179	Likely ^c	Likely	Likely
Paint and Allied Products	1,500	Likely	Likely	Possible
Organic Chemicals				
Toluene Diisocyanate	10	Probable	Possible	Likely
Chlorobenzene	6	Likely	Possible	Likely
Pesticides				
Active Ingredients	120	Likely ^c	Probable	Likely
Petroleum Rerefining	23	Likely	Likely	Likely
Rubber Products				
Tires and Inner Tubes	210	Probable	Probable	Negligible
Leather Tanning and Finishing				
Nonchrome Tan (Cattle)	16	3	200	None
No Beamhouse (Sheep)	29	1	20	None
Nonferrous Metal Smelting & Refining				
Primary Zinc	6	Possible (2)	Possible (1,200)	0.4%
Electroplating and Metal Finishing Job Shops	2,940	48	1,340	6.6%

a. Some, possibly most, of these chlorine operations, are captive and part of large industrial installations. This reduces the probability that all of these plants will close.

b. Price increases required to cover ISS costs. Plant closures are likely because the ability of small plants to raise prices is limited.

c. Some of these closures will be process unit shutdowns rather than closure of whole plants.

Sources: Development Planning and Research Associates, Inc. (Textile Manufacturing and Leather Tanning and Finishing); Energy and Environmental Analysis, Inc. (Inorganic Chemicals); Booz-Allen and Hamilton, Inc. (Electroplating and Metal Finishing); and Arthur D. Little, Inc., (all other industries).

- The testing requirement has the biggest impact on plants shipping small quantities of waste to off-site disposal. The 90-day on-site storage limitation and annual testing requirements result in high testing costs per metric ton for small waste volume generators.
- RCRA ISS provides only a weak incentive to reduce waste generation, unless the generator can eliminate waste altogether or sufficiently to qualify as a small waste generator.

B. HAZARDOUS WASTE GENERATION AND DISPOSAL PRACTICES

1. Generation

- Nearly 51,000 plants in the 22 industries studied generate approximately 26 million metric tons per year of hazardous waste (1978 basis) (see Table I-4). Of this total, about 8 million metric tons per year, disposed of by deep well injection and ocean dumping, are not included in the analysis. This report designates the remaining 18 million metric tons as ISS-regulated waste.
- Organic and inorganic chemicals account for 64% of the total wastes and 50% of the regulated wastes. The remaining wastes are broadly distributed among the other industries (see Figures I-3 and I-4).
- Small waste generators (less than 1000 kg/month) represent about one half of the total number of plants but generate only about 0.4% of the wastes.

2. Waste Management Practices

- Land-based practices are used to dispose of about 70% of the total wastes (see Figure I-5). Ocean disposal and deep well injection comprise the remainder.
- According to pre-RCRA practices, 41% of the ISS-regulated wastes are disposed of in sanitary landfills, and 38% in unlined impoundments; only 9% are sent to secure landfills (see Figure I-6). Operators of dumps and sanitary landfills will have to either upgrade their facilities to meet RCRA requirements or close them.

TABLE I-4

**ESTIMATE OF HAZARDOUS WASTE GENERATED BY
22 MANUFACTURING INDUSTRIES - 1978**

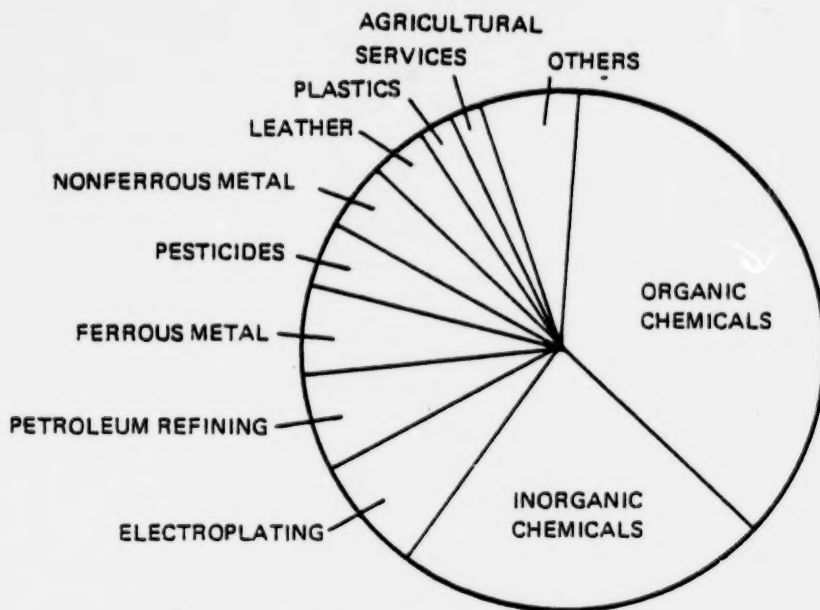
SIC Code	Industry	Waste Generated ^a (000 MT/yr, wet basis)
0711,0721,0729	Agricultural Services	466
22	Textile Manufacturing	224
2491	Wood Preserving	4
281	Inorganic Chemicals ^b	6,618
282	Plastics	562
283	Pharmaceuticals	116
285	Paint and Allied Products	114
286	Organic Chemicals ^c	10,058
28694,2879	Pesticides	701
2892	Explosives	7
2911	Petroleum Refining	1,925
2992	Petroleum Rerefining	81
30	Rubber Products	53
3111	Leather Tanning	628
331,332	Ferrous Metals	1,203
333,334	Nonferrous Metals	750
347	Electroplating	1,997
355,357	Special Machinery (office/computing)	74
367	Electronic Components	91
3691	Batteries	442
5085	Drum Reconditioning	74
5161	Chemical Wholesaling	5
	Total	26,193

a. Data from the segments studied, not necessarily the total quantity of hazardous waste generated by these industries.

b. Includes 2.7 million metric tons of hazardous waste disposed of by ocean disposal and deep well injection.

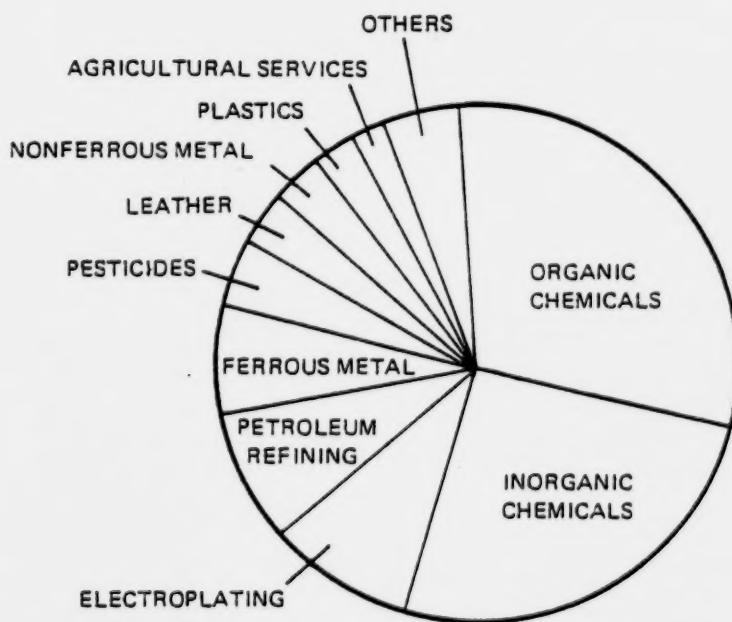
c. Data represent the 14 product segments studied, not the total volume of hazardous waste from the Organic Chemical industry. Includes 4.4 million metric tons of dilute aqueous wastes in two product segments that are disposed of by deep well injection.

Source: Arthur D. Little, Inc., estimates using data from Tables IV-1 through IV-22 of this report.



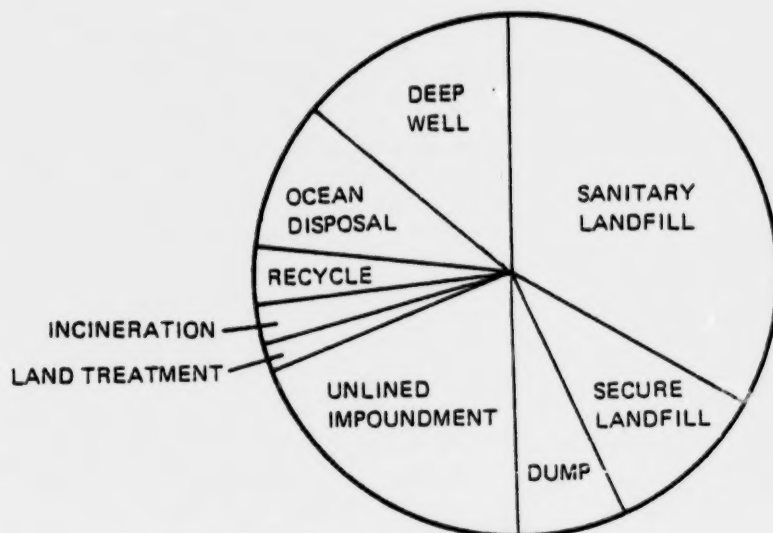
Source: Arthur D. Little, Inc.

FIGURE I-3 SOURCES OF TOTAL HAZARDOUS WASTES



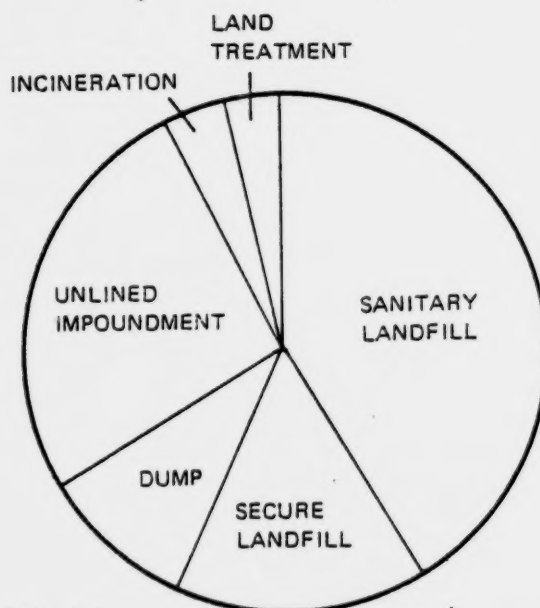
Source: Arthur D. Little, Inc.

FIGURE I-4 SOURCES OF ISS-REGULATED HAZARDOUS WASTES



Source: Arthur D. Little, Inc.

FIGURE I-5 PRE-RCRA WASTE MANAGEMENT PRACTICES FOR ALL WASTES



Source: Arthur D. Little, Inc.

FIGURE I-6 PRE-RCRA WASTE MANAGEMENT PRACTICES FOR ISS-REGULATED WASTES

II. INTRODUCTION

A. PURPOSE AND SCOPE

This report presents the results of an Economic Impact Analysis (EIA) of regulations implementing portions of Subtitle C of the Resource Conservation and Recovery Act of 1976 (RCRA). The regulations apply to generators and transporters of hazardous waste and to owners and operators of treatment, storage, and disposal facilities (TSDFs). They provide "cradle-to-grave" regulation of hazardous waste by channeling the flow of wastes from generators to disposers so that every step is carried out in a manner protecting human health and the natural environment.

Implementing the regulations imposes costs on all major parties — generators, transporters, and operators of TSDFs. Pursuant to Executive Order 12044, now revoked by and embodied in Executive Order 12291, this report presents estimates of these costs and the subsequent economic impacts of the costs on industrial generators of hazardous wastes.

The regulations and the associated EIA have gone through a series of major changes and revisions. In January 1979, EPA published a Draft EIA Report, evaluating the RCRA regulations proposed in December 1978.* In the following months, EPA received and reviewed comments on the proposed regulations and initiated additional data gathering and analysis to assist in preparing the final regulations.

On May 19, 1980, EPA promulgated revised regulations to implement RCRA Section 3001 defining hazardous waste as well as Interim Status Standards (ISS) for Section 3004 pertaining to administrative and operating practices at waste disposal facilities. EPA also repropounded standards of financial performance to assure the availability of funds for closing all hazardous waste treatment, storage, and disposal facilities and maintaining and monitoring disposal sites after closure. Most design or performance standards for the disposal facilities under Section 3004 are not part of ISS; they will be promulgated after ISS. EPA promulgated regulations to implement Sections 3002 (waste generation) and 3003 (waste transportation) earlier in 1980.

EPA also promulgated, on May 19, 1980, a set of consolidated permit regulations that implement parts of Section 3005, and incorporate other statutes into a unified hazardous waste management program. This EIA covers all of the regulations as of May 19, 1980 implementing RCRA Sections 3001, 3002, 3003, 3004 (ISS), and 3005. The regulations apply to all hazardous wastes as defined in RCRA Section 3001, and to all generators, transporters, and operators of TSDFs handling these wastes. The Act, together with its associated implementing regulations (40 CFR Part 261), contains three forms of hazardous waste definitions:

*Arthur D. Little, Inc., "Draft Economic Impact Analysis Subtitle C, Resource Conservation and Recovery Act of 1976, Regulatory Analysis Supplement," prepared for U.S. EPA, Office of Solid Waste, January 1979.

1. Wastes as defined in Section 1004, "which...may (A) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed."
2. Wastes that exhibit any of the characteristics listed in Subpart C of 40 CFR Part 261.
3. Wastes listed in Subpart D of this regulation.

The report analyzes and reports costs and impacts for 22 industries that are believed to generate most of the hazardous wastes so defined, and that are subject to the set of RCRA regulations described above. Several industries and waste classes are omitted from the analysis, as discussed below. This report presents the estimated quantities of hazardous waste generated by these U.S. industries, their incremental costs of compliance, and the resultant economic impacts. The 22 industries are listed in Table II-1. For the purposes of this analysis, the industries are further subdivided into 109 industry segments representing major products or product groups; they include about 51,000 manufacturing plants and service establishments in the United States.

This report does not consider the hazardous wastes generated by industries other than these 22, and does not consider all of the hazardous waste streams from the 22 industries, particularly the organic and inorganic chemical industries. For example, analysis of the organic chemical industry is limited to the segments where EPA had previously collected information on waste volumes and disposal practices.* As a result, the quantities of waste generated by all firms covered by the regulations and the resultant costs of compliance will be understated. The most important wastes have been included, however.

EPA's designations of waste streams to be considered hazardous have changed somewhat from those in the hazardous waste assessment reports of 1973-1976 that identify potentially hazardous waste streams.** Most of these changes are incorporated in this report. The cost and impact analysis does, however, include some industries with waste streams identified in the assessment reports as hazardous, although EPA now believes they may not be hazardous and has delisted them as hazardous or has suspended or deferred their listing. The compliance cost results for the textile, leather tanning, paint, and most of the nonferrous smelting and refining industries would be eliminated or reduced significantly if these waste streams had been excluded from the analysis.*** The aggregate national costs reported in Chapter VI are overstated by the inclusion of these four industries, if these wastes are not ultimately regulated.

*TRW Systems Group. TRW, Inc. "Assessment of Industrial Hazardous Waste Practices — Organic Chemicals, Pesticides and Explosives Industries," Final Report to U.S. EPA, Contract 68-01-2919, 1976.

**See list at end of Chapter IV.

***The preface to this report discusses these and other changes occurring during the preparation of this analysis that are not reflected in this report.

TABLE II-1
INDUSTRIES STUDIED

SIC Numbers

0711 } 0721 } 0729 }	The Agricultural Services Industry
2231 } 2251 } 2261 } 2269 } 2272 } 2291 } 2297 } 2299 }	The Textile Manufacturing Industry*
2419	The Wood Preserving Industry
2812 } 2816 } 2819 } 28194 }	The Inorganic Chemical Industry (partial)*
2821 } 2822 } 2823 } 2824 }	The Plastic Materials, Synthetic Rubbers, and Synthetic Fibers Industry
2831 } 2833 } 2834 }	The Pharmaceutical Industry
2851	The Paint and Allied Products Industry
28612 } 28615 } 2869 } 28692 }	The Organic Chemical Industry (partial)*
28694 } 2879 }	The Pesticide Industry
2892	The Commercial Explosives Industry
2911	The Petroleum Refining Industry
2992	The Petroleum Rerefining Industry

TABLE II-1 (Continued)

SIC Numbers

3011	}	The Rubber Products Industry
3021		
3031		
3041		
3069		
3111		The Leather Tanning and Finishing Industry*
3312	}	The Ferrous Metal Smelting and Refining Industry
3313		
332		
3331	}	The Nonferrous Metal Smelting and Refining Industry*
3332		
3333		
3334		
3339		
3341		
3471	}	The Electroplating and Metal Finishing Industry*
3479		
355	}	The Special Machinery Manufacturing Industry
357		
367		The Electronic Component Industry
3691	}	The Battery Industry
3692		
5085		The Drum Reconditioning Industry
5161		The Chemical Wholesaling Industry

*Industries for which new data have been developed since the draft EIA and for which quantitative analyses have been done.

Source: Arthur D. Little, Inc.

Several industries producing large quantities of waste are not discussed in this report because their waste has not been demonstrated to be hazardous or because their regulation has been postponed by EPA. These industries are phosphate mining, cement production, pulp and paper production, metal mining, oil and gas drilling and production, and electric utilities.

Hazardous waste management practices and state hazardous waste management regulations existing in 1976, when the Congress enacted RCRA, are the baseline from which incremental RCRA compliance activities and costs are taken. Since 1976, several states have enacted hazardous waste management regulations;

many waste generators and disposal facility operators have changed, and are continuing to change, their practices as required by the new state regulations and in anticipation of the RCRA regulations. State requirements predating RCRA are incorporated in the analysis by raising the baseline of industry practices in the ten states having pre-1976 requirements similar to RCRA ISS.* Changes in state regulations since 1976 have not been considered here because this analysis assumes that they result from the passage of RCRA.

Changes in industry practice between 1976 and 1980 are not reflected in the baseline practices used to calculate the incremental compliance costs because they are also said to be RCRA-induced. As a result, some plants, probably the large ones, have already incurred a portion of the costs estimated in this analysis; most small plants probably have not yet made the projected expenditures.

The RCRA ISS compliance costs are also incremental to expenditures for wastewater treatment as a result of the Federal Water Pollution Control Act (FWPCA) Amendments of 1972 and 1976. For some industries, pretreatment standards and BATEA (best available technology economically achievable) effluent guidelines will be promulgated and enforced during the same time frame as RCRA. The categories of baseline and incremental waste disposal costs for the RCRA and water regulations are identified in Figure II-1. Hazardous waste sludges generated from wastewater treatment for the first time after 1980 have both baseline and incremental hazardous waste disposal costs. The baseline (pre-RCRA) hazardous waste disposal costs are included in the water standards cost analysis, but not in the ISS analysis. Only the ISS incremental cost of disposal for the sludge is included in this EIA.

This analysis assumes that pre-RCRA waste disposal practices at generating plants and at off-site TSDFs will remain unchanged by the current set of regulations. Plants disposing of waste on site will continue to do so, and the location of off-site disposal facilities is assumed to remain unchanged; transportation costs do not increase. No shift in the actual mode of disposal, e.g., landfill, incinerator, is expected as a result of the ISS. Significant changes in the ways in which wastes are treated and disposed of are expected to occur after the promulgation of TSDF standards. Incremental costs attributable to such future facilities standards are not included here.

The ISS regulations apply to a number of designated waste management practices, not all of which are incorporated in this analysis. Tanks, surface impoundments, land treatment, landfills, and incinerators are included. Containers; waste piles; thermal, chemical, physical and biological treatment; underground (deep well) injection; and resource recovery are not included.

B. APPROACH

The analysis of the economic impact of the RCRA regulations involved a complex, highly interrelated set of analytic tasks, tied together through a computer

*California, Illinois, Indiana, Iowa, Louisiana, New York, Ohio, Oregon, Texas, and Wisconsin.

WASTE CATEGORIES	COST CATEGORIES	
	Waste Treatment/Disposal Practices	
	Pre-RCRA (1976)	Post-RCRA
Pre-RCRA (1976) • Process Waste • BPT Sludges	Baseline RCRA Cost	Incremental RCRA Cost
Post-RCRA • BAT Sludges • Pretreatment Sludges	Baseline RCRA Cost Incremental Wastewater Treatment Cost	Incremental RCRA Cost

Source: Arthur D. Little, Inc.

FIGURE II-1 HAZARDOUS WASTE TREATMENT AND DISPOSAL COST CATEGORIES

calculation and data management system. The analysis was broken into two major components: 1) estimating incremental compliance costs and 2) evaluating economic impacts.

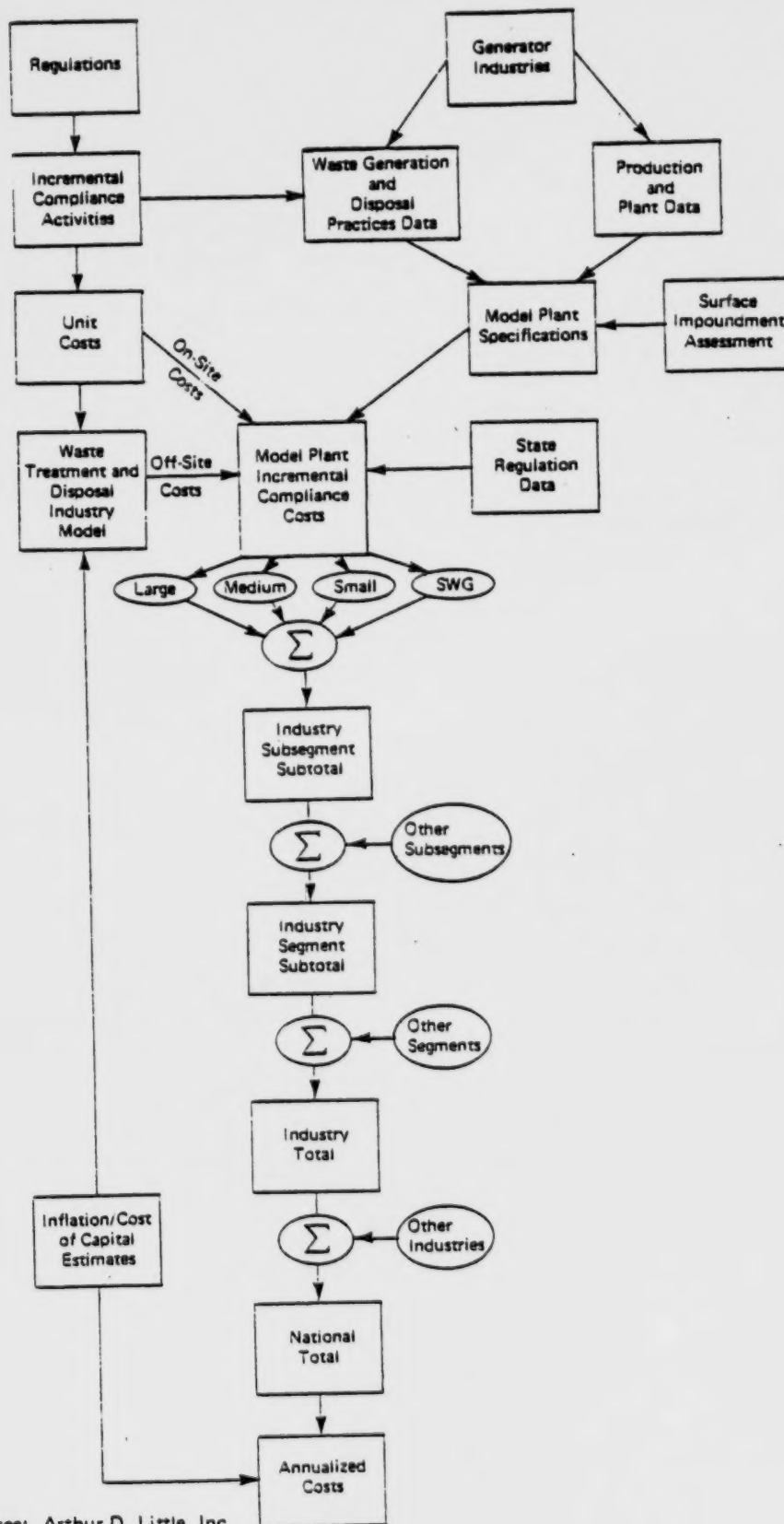
1. Incremental Compliance Costs

The compliance costs and resultant impacts described in the analysis are incremental to the costs and impacts of handling hazardous waste in traditional ways or according to state and Federal regulations in place prior to the set of RCRA regulations described above.

The analysis followed the approach depicted in Figure II-2. This figure shows the steps taken to develop estimates of incremental compliance costs on an industry-by-industry basis and for the nation as a whole. These costs provided the basis for estimating the economic impact on each of the industries, as shown below. This report is structured, in general, to parallel the flow of the analysis.

Chapter III and Appendix A describe the regulations and the compliance activities resulting from their implementation. Chapter IV describes the industries that generate hazardous wastes and contains data on quantities of waste generated by each industry, number of plants producing waste, and the waste management practices each industry will probably use, broken down by industry segment.

Much of the analysis and presentation of results is organized according to industry segments. Segments were chosen to group plants by products, production



Source: Arthur D. Little, Inc.

FIGURE II-2 FLOW DIAGRAM - INCREMENTAL COMPLIANCE COST ANALYSIS

processes, and waste generation characteristics. For example, chlorine is a segment of the inorganic chemical industry, and wool scouring is a segment of the textile industry. Not all industries are segmented.

The analysis develops incremental compliance costs in successive aggregating steps, beginning with the development of model plants, representing typical large, medium, and small plants (and a special category, small waste generators), within a single industry segment. Chapter V describes the model plant development process in more detail and discusses the basis of the unit costs for various on-site (at the waste-generating plant site) and off-site compliance activities. Unit costs are factors used to convert the compliance activities into incremental costs. Appendix B contains details of the derivation of unit costs. Production and plant data, surface impoundment specifications, and small waste generator data for each of the industries appear in Appendix G.

The incremental costs of off-site disposal to a waste generator were determined by estimating the increased prices a typical commercial TSDF would charge as a result of the regulations, assuming price increases in proportion to costs of operation. Appendix C describes the waste management firm model and the details of the development of off-site cost estimates.

Compliance costs were computed by applying the unit costs to the activities of a model plant and aggregating the results to obtain an industry total. A computer program was developed to carry out the myriad computations and accompanying bookkeeping. Sample calculations are presented in Appendix H and the computer program in Appendix I. Costs were identified and collected in several categories, shown in Table II-2. The compliance activities differentiate among types of operating or financial practices that must be changed to conform with the regulations. Listing costs by RCRA section associates the impacts with sections within the general provisions of the Act.

The cost types reflect different financial characteristics of the compliance costs. Some activities, such as providing a security fence, require an initial capital investment. Others, such as obtaining an EPA ID number, require an initial expenditure, but are normally expensed according to standard accounting practices. Many of the costs recur annually and are expenses like other operating costs of the plant. The closure fund arises out of the requirements for an operator of a TSDF to provide assurance that funds will be available for closing the facility. For a disposal facility, funds must be available for maintenance and monitoring after closure. For this analysis, a trust-fund approach to cover closure and post-closure was selected from several permissible options. Under this scheme, an operator would build up the fund over the first 20 years of operation.

The different types of costs were combined and annualized, using standard present-value discounting techniques. Appendix D describes the annual inflation assumptions and Appendix E derives the cost of capital (also the discount rate) used in the analysis.

TABLE II-2

COST CATEGORIES

COMPLIANCE ACTIVITIES

On-site Treatment & Disposal
Off-site Transportation, Treatment, and Disposal^a
Recordkeeping & Reporting
Monitoring & Testing
Administration
Training
Contingency
Closure Fund

COST TYPE

Capital – One-time Capital Investments
Initial – One-time Expenses
Annual – Recurring Compliance Costs
Closure Fund – Payments to Trust Fund over 20 Years to Cover Closure and Post-closure Costs

RCRA SECTION

3001 – Hazardous Waste Definition
3002 – Requirements for Generators
3003 – Requirements for Transporters
3004 – Requirements for Treaters (Disposers)
3005 – Permit Administration Requirement

a. Transportation costs are not included in the analysis of ISS regulations.

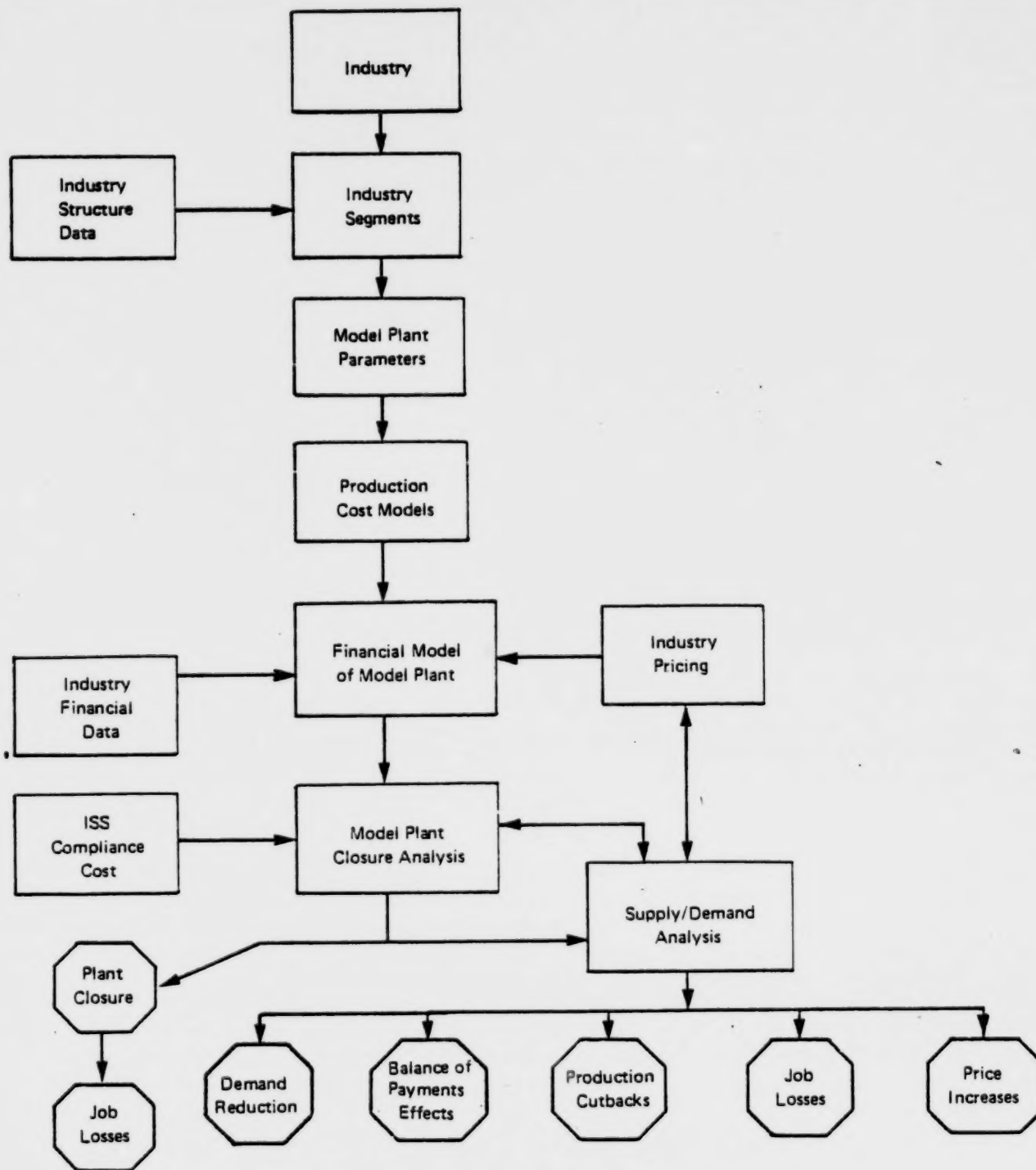
Source: Arthur D. Little, Inc.

Chapter VI summarizes the results of the compliance cost calculations and presents the results of a sensitivity analysis that examined the effects of variations on a number of the key assumptions.

2. Economic Impact Analysis

The economic impact analysis followed the general approach shown in Figure II-3. This analysis converted the compliance cost estimates into parameters of economic impact for each of the 109 industry segments. The parameters include:

- Annualized compliance cost as a percent of value added
- Plant closures
- Job losses
- U.S. production cutbacks
- Price increases
- U.S. demand reduction
- Balance of payments effects (shifts in import/export balances).



Source: Arthur D. Little, Inc.

FIGURE II-3 ECONOMIC IMPACT ANALYSIS SCHEMATIC

For this part of the overall impact analysis, the 22 industries were divided into two groups. The first group, designated "high-impact" in this report, includes six industries EPA identified at the beginning of the project as ones in which significant impacts might be experienced. The six industries are:

- Textile manufacturing
- Inorganic chemicals (selected segments)
- Organic chemicals (selected segments)
- Leather tanning and finishing
- Nonferrous metal smelting and refining
- Electroplating and metal finishing.

Quantitative economic analysis techniques were used to estimate impacts for these industries. In general, the financial models used had been developed earlier for EPA effluent guideline projects and were revised for the RCRA impact study. This process resulted in numerical estimates for plant closures and job losses. Chapter V describes the quantitative impact methodology in more detail.

The remaining 16 industries, as well as the other segments of the organic and inorganic chemical industries, were evaluated qualitatively by Arthur D. Little, Inc., to determine the likelihood of non-trivial changes in the impact measures. A change in an impact parameter of less than 0.5% was considered to be negligible, even if the likelihood of change was high. Probability descriptions were used to characterize expected changes greater than 0.5%. Chapter V describes the qualitative procedure in more detail.

Chapter VI summarizes the results of the economic impact analysis, together with the compliance cost summary. Each industry is discussed in detail in Appendix F. This appendix contains 22 parts, each containing a description of an industry and its important economic and technical characteristics, as well as tables displaying the results of the compliance cost and economic impact analyses for all industry segments.

Chapter VII, the last chapter of the report, discusses the limits of the analysis.

C. RELATION TO THE DRAFT ECONOMIC IMPACT ANALYSIS REPORT

The analysis included in the January 1979 Draft EIA was substantially upgraded in preparing this final EIA. The data base for waste generation and disposal was updated, the methodology for estimating compliance costs was made more sophisticated, and the economic impact analysis was conducted in a more rigorous fashion.

This final EIA includes the results of the following work tasks or studies undertaken since January 1979:

- Collection of limited new information on quantities of waste generated and waste disposal practices in the textile manufacturing, electroplating and metal finishing, leather tanning and finishing, and nonferrous metal smelting and refining industries, and in small portions of the organic and inorganic chemical industries.
- Review of the estimated quantities of waste generated by all 22 industries in light of a revised definition of hazardous waste, more recent data, and projected hazardous waste generation from wastewater treatment (BATEA and pretreatment) standards.
- Collection of information on the use and condition of surface impoundments by manufacturing industries, based on a previous survey by EPA's Office of Drinking Water.*
- Estimation of the incremental cost of compliance with the ISS for surface impoundments for the 22 waste-generating industries covered in this report.
- Estimation of the number of small waste generators (SWGs) and their waste quantities (as defined by the ISS and therefore excluded from many of the requirements applicable to waste generators).
- Analysis of the incremental cost of compliance with the ISS for model plants of at least four different sizes in all but two of the industries studied.
- Quantitative analysis of the potential for plant closures in the six "high impact" industry and product groups listed above for which new waste generation data were available.
- Qualitative analysis of the economic impact of incremental ISS compliance costs on 16 industries plus some product groups in the organic and inorganic chemical industries.
- Analysis of the incremental cost of compliance with the ISS and the economic impact for four industries and a major industry segment not included in the January 1979 EIA: agricultural services (pesticide application), wood preserving, drum reconditioning, chemical wholesaling, and captive electroplating.

*Surface Impoundment Assessment Comprehensive Listing (June 1980). Unpublished data from U.S. EPA, Office of Drinking Water.

III. BACKGROUND — THE HAZARDOUS WASTE MANAGEMENT REGULATORY SYSTEM

A. INTRODUCTION

This chapter summarizes the essential features of the EPA's hazardous waste management regulatory program to implement the statutory provisions of the 1976 Resource Conservation and Recovery Act (RCRA) Subtitle C. Its purpose is to identify how the regulations affect persons who generate hazardous waste, those who transport hazardous waste, and those who own or operate treatment, storage, or disposal facilities (TSDFs).

Ten states had enacted programs for regulating hazardous waste prior to the enactment of RCRA. Indeed, these state programs substantially influenced the proposed Federal regulations. As a result, facilities managing hazardous waste in these states are already bearing costs for compliance with requirements that are similar, or identical, to those imposed by the Federal regulations. Therefore, this chapter also includes a brief discussion of state regulations.

B. OVERVIEW OF FEDERAL REGULATORY PROGRAM

The Federal regulations were divided into six substantive Parts (260-265), published or republished in 45 *Federal Register* 33066 (May 19, 1980) as units of Title 40 of the Code of Federal Regulations. The effective date for most of the regulations was November 19, 1980. Two additional Parts of the Code (Parts 122 and 124) relating to permitting procedures are described here for completeness. A description of the different Parts, in terms of their authorizing RCRA statutory section, follows:

- Part 260 includes basic program definitions, provisions for confidentiality of information, a short overview of the hazardous waste regulatory program created by RCRA and the subsequent Parts, and general provisions for rulemaking, testing methods, and exclusions.
- Part 261 implements RCRA Section 3001 and defines hazardous waste, as well as the criteria, characteristics, and lists of substances that are subject to the regulatory program.
- Part 262 implements RCRA Section 3002 and defines the compliance obligations for generators of hazardous waste.
- Part 263 implements RCRA Section 3003 and defines the compliance obligations for transporters of hazardous waste.
- Part 264 implements RCRA Section 3004 and establishes the standards a new or existing facility must meet for continued operation and after receiving a permit.

- Part 265 implements RCRA Section 3004 and defines the Interim Status Standards — administrative, technical, operating, and financial — that a facility must meet while awaiting administrative disposition of the formal permit applications.
- Parts 122 and 124 implement RCRA Section 3005 and describe the permitting procedures to be followed.

The overall Subtitle C regulatory program channels hazardous wastes from generators to facilities with resources, expertise, and capabilities appropriate to treat, store, or dispose of the wastes in a manner that protects human health and the natural environment. Facilities will be subject to permitting requirements intended to ensure, among other things, that they maintain technical standards and appropriate operating procedures. Generators of hazardous waste will be required to direct their waste only to facilities with interim status or with permits.

Transporters will be required to maintain control over wastes in shipment and to ensure that wastes are directed only to appropriate facilities. A central device for monitoring and control of waste movement is the shipping manifest. As defined in the regulations, the manifest serves different purposes. As executed by the waste generator, the manifest identifies the waste and directs it to its ultimate destination. The transporter uses the manifest (and related documentation) for maintaining control during transportation. The end-point facility uses the manifest as a delivery document to be executed and returned to the generator/shipper as proof of receipt.

These regulations for administration and enforcement set up procedures for record retention, reporting, and identification. Regulations implementing RCRA Section 3010 define a notification scheme that enables the EPA to assign unique identification codes to each entity affected by the regulations.

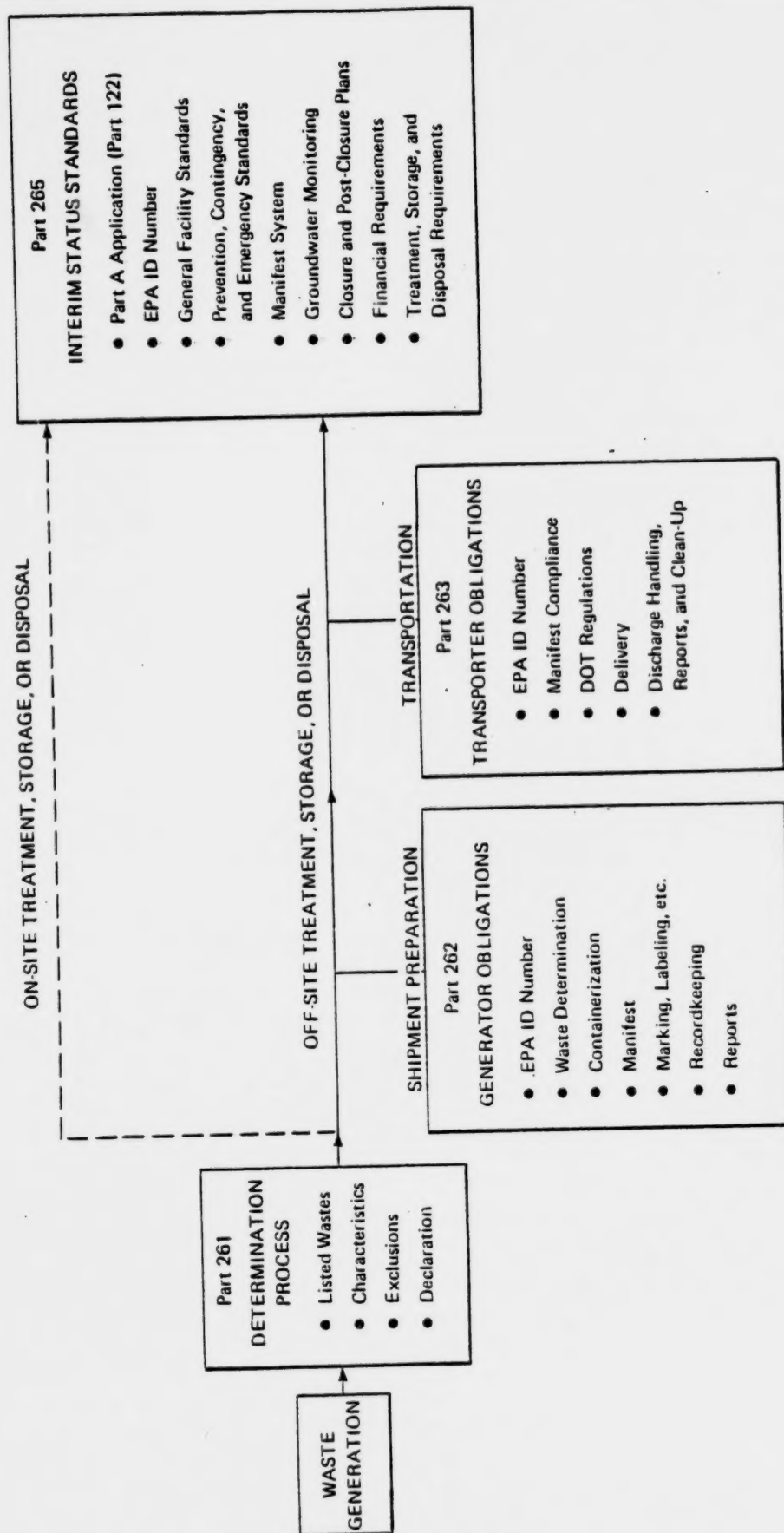
Appendix A describes specific compliance requirements associated with each Part of the regulations. These requirements are the basis from which compliance activities and their incremental costs arise.

C. COMPLIANCE ACTIVITIES

Compliance with the RCRA regulations and similar state hazardous waste management regulations requires generators, transporters, and operators of TSDFs to undertake a new set of activities. The costs associated with these activities represent the incremental compliance costs.

Figure III-1 shows the general relationship of the RCRA regulations to the affected parties. In order to organize the various activities and associated costs, all compliance activities are described according to the following scheme:

- Treatment/Disposal
- Recordkeeping and Reporting
- Monitoring and Testing



Source: Arthur D. Little, Inc.

FIGURE III-1 OVERVIEW OF HAZARDOUS WASTE REGULATORY PROGRAM

- Administration
- Training
- Contingency Plan
- Closure and Post-Closure Fund, including closure and post-closure technical costs and financial requirements.

The following discussion provides examples of each type of compliance activity. Further discussion is included in Appendix B, the development of unit costs for each compliance activity.

On-site treatment/disposal activities include installing and operating a runoff control system and the annual closure of landfill cells. This latter activity occurs as a continuing operation, not as a one-time closure activity.

Recordkeeping and reporting costs include applying for an ID Code; preparing, filing, and tracking manifests; preparing and filing Annual Reports and Exception Reports, if needed. Some of the activities involved in submitting Part A of the permit application are also considered recordkeeping. Disposers must maintain records of employee training, disposition of each incoming batch or shipment, and monitoring data. The costs involved in all these activities are primarily labor costs; few other kinds of expenses are incurred.

Monitoring and testing activities split into those carried out by a generator and those performed at treatment/disposal facilities. A generator may employ tests to determine if a waste is hazardous or, conversely, to demonstrate that it is not. A greater testing requirement falls on operators of treatment/disposal facilities, who must perform tests on incoming shipments to ensure proper management of the wastes. Groundwater monitoring is required at landfills, surface impoundments, and land treatment facilities. Soil monitoring is required at land treatment facilities, and incinerators must monitor the combustion process. These activities are costly and require both ongoing labor costs and, for groundwater monitoring, substantial investment in wells.

Administrative activities include a number of activities that are more or less implicitly associated with the regulations. The associated costs are all labor-based. These activities include initially reading and reviewing the regulations, initially assessing internal compliance, reviewing annually file contents and new requirements, designing a manifest system, labeling, and similar continuing functions. Treatment/disposal facilities must prepare a closure and post-closure plan, set up an operating log, and perform inspections. Some of the activities involved in preparing Part A of the permit application are allocated to this category.

Training is required at every TSDF whether on site or off site. Specific activities include setting up a course and giving it to all employees involved in the hazardous waste management operation.

Contingency activities are designed to reduce the probability of spills and incidents (security) and also to cope with those events should they occur. These

activities include installing fencing, posting signs, acquiring waste holding tanks and contingency equipment, and providing for spill containment. Operators of TSDFs must prepare a contingency plan in conjunction with submitting Part A of the permit application.

Closure and post-closure activities include a series of activities to close and secure a facility once operations cease and, for disposal facilities (where wastes remain in the ground after closure), to continue to monitor the site and surroundings to identify any discharge from the facility into underlying groundwater. These post-closure activities must continue for 30 years from the date of closure, unless the EPA Regional Administrator permits a shorter or requires a longer compliance period. Closure activities consist of capping or covering secure landfills, land treatment areas, and surface impoundments; providing runoff controls; and replanting the overlying soil cover. Closing an incinerator requires removing or destroying any unburned waste and decontaminating the facility. Generators using off-site disposal facilities must decontaminate any tanks used for holding or storing hazardous wastes.

The closure and post-closure activities and associated costs will not arise until a generator using tanks or a TSDF ceases to operate; this study assumes a normal lifetime of 20 years. To satisfy the financial requirements of the RCRA regulations, each owner or operator must provide assurance that funds sufficient to cover necessary closure and post-closure activities will be available. The owner or operator can use one of several assurance mechanisms: a trust fund, an irrevocable stand-by letter of credit, or a surety bond. For some firms demonstrating that they can conform with EPA-specified financial criteria, no financial requirements will be imposed. This analysis assumed that all owners and operators will use trust funds built up over the first twenty years of operation to satisfy their financial requirements.

D. STATE REGULATORY REQUIREMENTS

1. Background

Between 1965 and 1975, many, perhaps a majority, of the states developed solid waste regulatory programs. As a general rule, these solid waste provisions were the basis for further regulation of hazardous waste.

When the U.S. Congress enacted RCRA in October 1976, many states passed similar state provisions. The latter statutes demonstrate the considerable influence of the Federal provisions. Accordingly, they are considered as "RCRA induced" and are not included in the baseline of state regulatory schemes that impose compliance costs independent of the new Federal requirements.

Ten states had significant hazardous waste regulatory requirements prior to 1976: California, Illinois, Indiana, Iowa, Louisiana, New York, Ohio, Oregon, Texas, and Wisconsin. No two of these states take an identical approach. It is not possible to determine accurately whether requirements were strictly or loosely

enforced or to identify whether informal, but important, requirements existed. The analysis for this report "averages" state regulations and assigns pre-RCRA state-imposed costs on the basis of that average. The requirements described below reflect the average standards.

A few states, in addition to those cited, had some hazardous waste management requirements prior to RCRA. These states were excluded from the baseline computation, however, because the requirements were minimal in terms of cost impact.

2. Specific Requirements

Typical regulatory requirements for the ten states are summarized below. The summary is organized in terms of RCRA section numbers to permit comparison of compliance obligations. In general, the average pre-RCRA state program depends on a manifest system, thus imposing some administrative and related costs on all generators. Transporters or haulers are regulated or licensed and monitoring and enforcement data are provided through reporting obligations. Hazardous waste is determined by established lists and criteria. Once identified, the waste is directed to regulated facilities. The technical aspects of a pre-RCRA state regulatory scheme are typically confined to off-site facilities and do not apply to facilities on the generator's site.

a. Section 3001 Requirements

The states' definitions of hazardous waste are substantially similar to that in the Federal regulations. The common purpose is to protect both public health and the natural environment. The average state program follows the "list and characteristic" approach of the Federal regulations, although perhaps with less detail. Thus, the 3001 compliance costs are substantially the same as existing costs in the 10 states.

b. Section 3002 Requirements

A shipping document/manifest system lies at the heart of the average state program. This imposes on generators recordkeeping and reporting requirements similar to those of the Federal approach. The shipping preparation obligations for containment, packaging, and labeling are also substantially similar, largely because of the common influence of the U.S. Department of Transportation (DOT) regulations on the different state transportation regulatory schemes.

The pre-RCRA state programs, however, generally do not provide the exclusion that exists in the Section 3002 regulations for waste generated below specific amounts. Nor are identification codes required, although it seems implicit in the reporting requirements that there be a simple means of identifying information sources.

c. Section 3003 Requirements

Because of reliance on the manifest system, the average state approach is similar to that of the Federal regulations in terms of impacts on transporters. The initial regulatory measure of many states was to regulate waste transporters. All programs examined show the influence of the DOT regulations.

d. Section 3004 and Section 3005 Requirements

The major differences between pre-RCRA state hazardous waste programs and the proposed Federal approach are in the areas of facility regulation and permitting. The pre-1976 state standards and requirements did not apply to on-site facilities and the regulatory approaches of the different states varied considerably. For example, California, Illinois, and Texas developed a fairly detailed approach to facility regulation over a period of years. Other states adopted a simple "registration" approach that required facilities to identify themselves, provide reports, and be subject to inspection and controls over new construction. In a few states, the appropriate state agency provided expertise (in the form of advice and technical assistance) to facilities, and directed (or assisted) generators in the selection of a particular facility for a particular waste.

Before 1976, few states imposed formal permitting obligations comparable to those in the 3005 regulations. The average pre-1976 state program lacked comprehensive application and paperwork requirements and did not attempt public participation/input through notices and hearings. Geological, hydrological, or engineering surveys were required in appropriate cases and technical standards were fulfilled largely through such informal mechanisms as technical assistance and advice. In general, financial requirements were not imposed. Thus, most of the compliance requirements for the Section 3004 Interim Status Standards and Section 3005 regulations are in addition to those imposed by the average state program in existence before 1976.

IV. HAZARDOUS WASTE GENERATION, DISPOSAL, AND TRANSPORTATION PRACTICES

A. INDUSTRY SEGMENT DATA

Compliance costs depend on the types and amount of wastes generated, and on the treatment and disposal techniques employed for each waste stream. Tables IV-1 through IV-22 contain data on "characteristic" wastes, listed wastes, annual waste generation, ratio of waste generation to production, estimated distribution of current (pre-November 1980) waste management practices, and similar estimates for practices expected after the final technical permitting regulations for treatment, storage, and disposal facilities (TSDFs) are promulgated.

"Characteristic" waste is the waste identified as hazardous, using terms given in the referenced assessment reports or by other contractors who provided more recent supplementary data. For the purpose of this analysis, listed wastes are those wastes identified in Part 261 of the *Federal Register* Vol. 45, No. 98, May 19, 1980, p. 47832 *et seq.* Where the characteristic wastes are believed to be the same as the listed waste, they are shown in parallel; there are many instances in the tables, however, where the characteristic wastes are not listed, and vice versa.

In some industries, e.g., pesticides, the characteristic wastes have been aggregated to provide a total for the industry segment. The listed wastes may represent only a fraction of the total hazardous waste believed to be generated by that segment.

The waste quantity estimates are based primarily on a series of hazardous waste assessment reports prepared for EPA by contractors mainly during 1973-1976.* These estimates were revised and further refined by EPA and Arthur D. Little, Inc. The EPA revisions resulted from new information obtained from effluent guideline projects. In addition, a detailed re-examination of the waste generation estimates, including gathering of a limited amount of new data, was undertaken for six industries identified by EPA as having a high probability of adverse economic impact under RCRA (textile manufacturing, leather tanning and finishing, electroplating and metal finishing, inorganic chemicals [some segments], organic chemicals [some segments], and nonferrous metal smelting and refining).** This examination resulted in significant changes in the estimates of hazardous waste produced by most of these industries.

The estimate of total waste quantity generated has been revised to reflect 1978 production levels. For some industries, this estimate is based on actual data provided by the contractors. For the other industries, the estimated total is obtained by multiplying 1978 production by the waste generation rate given in the industry assessment reports or reported by Battelle.***

*These contractors are identified in the list in Section E at the end of this chapter.

**This work was performed by Arthur D. Little, Inc.; Sverdrup and Parcel, Inc.; Hamilton Standard, Inc.; Temple, Barker and Sloane, Inc.; Jacobs Engineering Group, Inc.; and Pope-Reid Associates, Inc.

***Battelle Columbus Laboratories. "Cost of Compliance with Hazardous Waste Management Regulations." Draft Report to U.S. EPA, Office of Solid Waste, Hazardous Waste Division, Contract 68-01-4360, May 1978.

TABLE IV-1
HAZARDOUS WASTE GENERATION IN THE AGRICULTURAL SERVICES INDUSTRY

Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practices	
		(1978 MT - wet)	Rate ^a	Practice %	Practice %	Practice %	Practice %
Characteristic Waste							
Agricultural Services (SIC 0711)							
Pesticide Containers		13,000	182	Landfill 65	Dump 35	Secure Landfill 100	
Dilute Pesticide Solutions and Waste Pesticides		453,000 ^b		Dump 70	Recycle 30	Unlined Lagoon <1	
Total		466,000					

^aRate - metric tons waste/thousand metric tons of active ingredients.

^bAssumed use of 88,100 metric tons of active ingredients in 1978.

Sources: Energy Resources Company, Inc. "Economic Impact Analysis of Waste Management Regulations on Selected Generating Industries." Prepared for U.S. EPA, December 1978. Arthur D. Little, Inc., estimates.

TABLE IV-2

HAZARDOUS WASTE GENERATION IN THE TEXTILE MANUFACTURING INDUSTRY

Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practice	
		Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %
Characteristic Waste <u>Wool Finishing</u> <u>(SIC 2231)</u>	Indirect Discharge	8,100	140	Recycle	Landfill		Secure Landfill	
				3	97		100	
Direct Discharge		7,300 ^b	130	Land Treatment	Unlined Lagoon		Lined Lagoon	Secure Landfill
				40	10		10	90
<u>Knit Fabric Finishing</u> <u>(SIC 2251, 2254, 2257, 2259)</u>	Simple Indirect Discharge	4,700	60	Recycle	Landfill		Secure Landfill	
				10	90		100	
Simple Direct Discharge		11,800	60	Land Treatment	Unlined Lagoon		Land Treatment	Secure Landfill
				47	8		40	60
Complex Indirect Discharge		1,400	40		Landfill		Secure Landfill	
					100		100	
Complex Direct Discharge		5,200	55	Land Treatment	Unlined Lagoon		Land Treatment	Secure Landfill
				25	13		25	75
Hosiery Indirect Discharge		600	40	Recycle	Landfill		Secure Landfill	
				7	93		100	
Hosiery Direct Discharge		500	60	Land Treatment			Land Treatment	Secure Landfill
				60			60	40

TABLE IV-2 (Continued)

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practice	
			Total	Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %
Woven Fabric Finishing (SIC 2261, 2262)			3,300	40	Recycle 10	Landfill 90	Unlined Lagoon >1	Secure Landfill 100	
Simple Indirect Discharge	Woven Fabric Dyeing and Finishing Wastewater			55	Land Treatment 60	Unlined Lagoon 3	Landfill 37	Land Treatment 60	Secure Landfill 40
Simple Direct Discharge	Treatment Sludges (deferred)		11,500						
Complex Indirect Discharge			6,700	65	Landfill 100			Secure Landfill 100	
Complex Direct Discharge			14,200	100	Recycle 14	Unlined Lagoon 52	Landfill 34	Lined Lagoon 50	Secure Landfill 50
Complex and Desize Indirect Discharge			5,100	110	Landfill 100			Secure Landfill 100	
Complex and Desize Direct Discharge			112,000	180	Land Treatment 64	Secure Landfill <1	Landfill 35	Land Treatment 60	Secure Landfill 40
Carpet Finishing (SIC 2269)			93	25	Secure Landfill 100			Secure Landfill 100	
Indirect Discharge								Land Treatment 69	
Direct Discharge			11,800	60	Land Treatment 69		Landfill 31	Land Treatment 69	Secure Landfill 31

TABLE IV-2 (Continued)

Characteristic Waste <u>Stock & Yarn Finishing</u> <u>(SIC 2272)</u>	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practices		
			(1978 MT - wet) Total	Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %	Practice %
Indirect Discharge			5,400	40	Recycle 5	Landfill 80	Unlined Lagoon 15	Secure Landfill 100		
Direct Discharge			9,900	30	Land Treatment 70		Landfill 30	Land Treatment 70	Secure Landfill 30	
<u>Felted Fabric Processing</u> <u>(SIC 2281)</u>										
Indirect Discharge			3	175	Secure Landfill 100			Secure Landfill 100		
Direct Discharge			0	20						
<u>Nonwoven Manufacturing</u> <u>(SIC 2297)</u>										
Indirect Discharge			31	25	Secure Landfill 100			Secure Landfill 100		
Direct Discharge			108	13	Secure Landfill 100			Secure Landfill 100		
<u>Wool Scouring</u> <u>(SIC 2299)</u>										
Indirect Discharge			0							
Direct Discharge			0							
Total			224,000							

Note: About 15% of all plants generate waste solvent. The industry total is about 600 metric tons.

^aRate = metric tons waste/thousand metric tons of product.

Sources: Versar, Inc. "Assessment of Industrial Hazardous Waste Practices, Textile Industry." Prepared for U.S. EPA, Office of Solid Waste Management Programs, Contract No. 68-01-3178, June 1976.

Estimates by Arthur D. Little, Inc.; Development Planning and Research Associates, Inc.; Pope-Reid Associates, Inc.; Sverdrup and Parcel and Associates, Inc.

TABLE IV-3
HAZARDOUS WASTE GENERATION IN THE WOOD PRESERVING INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated (1978 MT - wet) Total	Estimated Current Waste Management Practices		RCRA Management Practice	
				Practice %	Practice %	Practice %	Practice %
Wood Preserving (SIC 2491)		K0001 - Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol (T)	4,000	Landfill 98	Unlined Lagoon 2	Secure Landfill 100	
Total			4,000				

Sources: Arthur D. Little, Inc. estimates.

TABLE IV-4

HAZARDOUS WASTE GENERATION IN THE INORGANIC CHEMICAL INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practice	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %
<u>Chlor-Alkali Production</u> (SIC 2812)									
Chlorine-Mercury Cell: Brine purification mud. Hg-containing waste from cell room		K071 - Brine purification muds from the mercury cell process in chlorine production, where separately prepurified brine is not used (T)	160,700	85.8 ^b	Secure Landfill 55	Unlined Lagoon 45		Secure Landfill 100	
Graphite anode wastes, tail gas and miscellaneous sludges		Mercury-bearing sludges from the mercury cell process in chlorine production (T)							
Chlorine - Diaphragm Cell: Brine purification and cell wastes		Wastewater treatment sludge from the diaphragm cell process using graphite anodes in the production of chlorine (Deferred)	727,000	95.4 ^c	Secure Landfill 75	Unlined Lagoon 25		Secure Landfill 100	
<u>TiO₂ - Chloride Process</u> (SIC 2816)									
Wastewater treatment sludge. Air pollution control (scrubber) sludge		K074 - Wastewater treatment sludges from the production of TiO ₂ pigment using chromium-bearing ores by the chloride process (T)	446,700	1872 ^d	Landfill 2	Unlined Lagoon 33	Secure Landfill 65	Secure Landfill 50 Ocean Disposal 50	
<u>TiO₂ - Chloride, Process Using Ilmenite Ore</u>									
Wastewater treatment sludge, etc.			2 x 10 ⁶	4230 ^e	Deep Well Injection 40	Ocean Disposal 40	Secure Landfill 20	Secure Landfill 60 Deep Well Injection 40	

TABLE IV-4 (Continued)

Waste Type	Characteristic Waste	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practices	
			(1978 MT - wet) Total	Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %
TiO ₂ - Sulfate Process: Wastewater treatment sludge. Unreacted or spent ore. Air pollution control (scrubber) sludge. Spills, leaks, equipment and area washdown.		Wastewater treatment sludges from the production of TiO ₂ pigment using chromium-bearing ores by the sulfate process (Deferred)	3,056 x 10 ⁶	15,700 ^f	Ocean Disposal 35	Unlined Lagoon 25		Ocean Disposal 50	Secure Landfill 50
Chrome Pigments: Metal-contaminated sludge from wastewater treatment.		K002 - Wastewater treatment sludge from the production of chrome yellow and orange pigments (T)	18,800	329 ^f	Secure Landfill 100			Secure Landfill 100	
		K005 - Wastewater treatment sludge from the production of chrome green pigments (T)							
		K006 - Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated) (T)							
		K008 - Oven residue from the production of chrome oxide green pigments (T)							
		K003 - Wastewater treatment sludge from the production of molybdate orange pigments (T)							
		K004 - Wastewater treatment sludge from the production of zinc yellow pigments (T)							
		K007 - Wastewater treatment sludge from the production of iron blue pigments (T)							
		Antimony bearing wastewater treatment sludges from the production of antimony oxide (T)							

TABLE IV-4 (Continued)

Waste Type	Characteristic Waste	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practices	
			(1978 MT – wet) Total	Rate ^a	Practice %	Practice %	Practice %	Practice %
Sodium Dichromate (SIC 2819)	Spent ore wastewater treatment sludge		202,200 ^g	1,224 ^h	Unlined Lagoon 32	Secure Landfill 68	Secure Landfill 100	
Phosphorus Pentasulfide Production (SIC 2819)	Arsenic and phosphorus wastes		120	2	Landfill in Drums 100		Secure Landfill in Drums 100	
Phosphorus Trichloride (SIC 2819)	Arsenic trichloride waste	K084 – Wastewater treatment sludges generated during the production of veterinary pharmaceuticals from arsenic or organo-arsenic compounds. (T)	67	1.0	Landfill in Drums 100		Secure Landfill in Drums 100	
Boric Acid	Arsenic-containing sludges		6,000		Secure Landfill 100		Secure Landfill 100	
Total			6,618,000					

^aRate = metric tons waste/thousand metric tons of product.^bAssumed 71% solids.^cAssumed 44% solids.^dAssumed 40% solids.^eAssumed 26% solids.^fAssumed 35% solids.^gPlant expected to discontinue operations, other processes do not produce hazardous waste.^hAssumed 80% solids.

Sources: Versar, Inc. "Assessment of Industrial Hazardous Waste Practices, Inorganic Chemicals Industry." Final Report to U.S. EPA, Office of Solid Waste Management Programs, Contract No. 68-01-2246, March 1975.

Estimates by Arthur D. Little, Inc.; Energy and Environmental Analysis, Inc.; Jacobs Engineering Co.; Pope-Reid Associates, Inc.

TABLE IV-5

HAZARDOUS WASTE GENERATION IN THE PLASTIC MATERIALS, SYNTHETIC RUBBERS,
AND SYNTHETIC FIBERS INDUSTRY

Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practice	
		Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
<u>Characteristic Waste</u>							
<u>Plastic Materials and Resins</u>							
<u>Phenolic Resins</u> (SIC 2821)							
Aqueous solution of phenol/ formaldehyde		325,000	533 ^b	Landfill 33	Incineration 1 50	Incineration 1 100	Unlined Lagoon 17
Semi-solid waste containing phenol		36,000	60 ^c	Landfill 100		Incineration 100	
<u>Amino Resins</u> (SIC 2821)							
Filter Cake		910	2.4	Landfill 100		Secure Landfill 100	
<u>Coumarone-Indene Resins^d</u> (SIC 2821)							
Still Bottoms		5,300	36	Incineration 1 100		Incineration 1 100	
<u>Polypropylene^d</u> (SIC 2821)							
Still Bottoms		6,400	4.6	Incineration 1 100		Incineration 1 100	
<u>ABS/SAN Resins^d</u> (SIC 2821)							
Still Bottoms		3,000	5.0	Incineration 1 100		Incineration 1 100	

TABLE IV-5 (Continued)

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated (1978 MT - wet)		Estimated Current Waste Management Practices		RCRA Management Practices	
					Practice %	Practice %	Practice %	Practice %
Alkyd Resins (SIC 2821)			32	0.1	Landfill 100		Secure Landfill 100	
Contaminated floor sweepings								
Polyethylene ^d (SIC 2821)			14,100	8.1	Incineration 1 100		Incineration 1 100	
Still Bottoms								
Synthetic Rubbers			8,200	6.0	Incineration 1 100		Incineration 1 100	
SB Rubber ^d (SIC 2822)								
Still Bottoms			36	0.1	Incineration 1 100		Incineration 1 100	
Polybutadiene ^d Still Bottoms								
Neoprene ^d Still Bottoms			9,700	60	Incineration 2 100		Incineration 2 100	
Cellulosic Manmade Fibers (SIC 2823)								
Rayon Fibers			82,100	200	Secure Landfill 68	Unlined Lagoon 32	Secure Landfill 100	
Zinc-containing waste- water treatment sludge								

TABLE IV-5 (Continued)

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated (1978 MT - wet) Total	Estimated Current Waste Management Practices		RCRA Management Practice	
				Practice %	Practice %	Practice %	Practice %
Synthetic Organic Fibers (SIC 2824)							
Acrylic Fibers							
Zinc-containing waste- water treatment sludge			70,000	200	Secure Landfill 100	Secure Landfill 100	
Total			562,000				

^aRate = metric tons waste/thousand metric tons of product.

^bContains 15% organics.

^cAssumed 50% organics.

^dDisposal practices already meet proposed RCRA standards.

Sources: Foster D. Snell, Inc. "Assessment of Industrial Hazardous Waste Practices: Rubber and Plastics Industry: Chapter II: Plastics and Materials and Synthetic Industry (SIC 282)." Final Report for U.S. EPA, Office of Solid Waste Management Programs, Hazardous Waste Management Division, Contract No. 68-01-3194, March 1978.

Arthur D. Little, Inc., estimates.

TABLE IV-6

HAZARDOUS WASTE GENERATION IN THE PHARMACEUTICAL INDUSTRY

Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practices	
		Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Characteristic Waste							
Biological Products (SIC 2831)		690		Incineration 1 100		Incineration 1 100	
Process wastes and waste solvents							
Medicinals and Botanicals (SIC 2833)		6,400	100	Incineration 2 100		Incineration 2 100	
Halogenated waste solvents							
Nonhalogenated solvents		74,200	1,160	Incineration 1 100		Incineration 1 100	
Organic chemical residue		25,600	400	Landfill 50	Incineration 1 50	Incineration 1 75	Landfill 25
Heavy metal wastes		6,000	94	Secure Landfill 100		Incineration 3 100	
High inert content wastes (flammable and nonflammable)		3,200	50	Landfill 45	Secure Landfill 30	Incineration 1 40	Secure Landfill 60
Pharmaceutical Preparations (SIC 2834)							
Returned goods, and reject materials		600	1,000	Landfill 90	Incineration 1 10	Landfill 90	Incineration 2 10
Total		116,000					

^aRate = metric tons waste/thousand metric tons of product.

Sources: "Pharmaceutical Industry: Hazardous Waste Generation, Treatment, and Disposal." Prepared for U.S. EPA, Contract No. 68-01-2684, 1976.

Arthur D. Little, Inc., estimates.

TABLE IV-7

HAZARDOUS WASTE GENERATION IN THE PAINT AND ALLIED PRODUCTS INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity		Estimated Current Waste Management Practices		RCRA Management Practice	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Paint and Allied Products (SIC 2851)								
Cleaning waste and wastewater treatment sludge		K079 - Water or caustic cleaning wastes from equipment and tank cleaning from paint manufacturing (T)	31,000	7.4	Landfill 100		Secure Landfill 100	
		K081 - Wastewater treatment sludges from paint manufacturing (T)						
Solvent cleaning waste and still bottoms		K078 - Solvent cleaning wastes from equipment and tank cleaning from paint manufacturing (I, T)	65,000 ^b	15.6	Incineration 1 40	Landfill 60	Incineration 3 90	Secure Landfill 10
Air pollution control residues (paint)		K082 - Emission control dust or sludge from paint manufacturing (T)	1,800	0.44	Landfill 100		Secure Landfill 100	
Spills and spoiled batches			11,000	2.6	Landfill 100		Incineration 3 90	Secure Landfill 10
Raw materials packaging			2,000 ^c	0.48	Landfill 50	Incineration 3 50	Incineration 3 100b	
Total			114,000					

^aRate = metric tons waste/million liters of total paint production (1 million liters = 1,200 metric tons).^bResults in 5% ash which requires secure landfill.^cAssumes segregation of packaging materials contaminated with hazardous waste.

Sources: "Assessment of Industrial Hazardous Waste Practices: Paint and Allied Products Industry Contract Solvent Reclaiming Operations, and Factory Applications of Coatings." Prepared for U.S. EPA, Contract No. 68-01-2656, 1976. Arthur D. Little, Inc., estimates.

TABLE IV-8

HAZARDOUS WASTE GENERATION IN THE ORGANIC CHEMICAL INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practices	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
<u>Lead Alkyls (SIC 2869)</u> Lead sludge from setting basin		Lead slag from lead alkyl production (T) (Proposed)	36,000	100	Incineration 1 100		Incineration 3 100	
<u>Maleic anhydride (SIC 2869)</u> Still bottoms			4,500	30	Landfill 100		Secure Landfill 100	
<u>Methyl Methacrylate (SIC 2869)</u> Heavy ends		Distillation bottoms from methanol recovery in methyl methacrylate production (O)	31,000	86	Landfill 80	Secure Landfill 20	Incineration 1 100	
<u>Toluene Dithiocyanate (SIC 2865)</u> Centrifuge residue sludges		K027 - Centrifuge residues from toluene dithiocyanate production (T)	5,700	21	Landfill 100		Incineration 1 100	
<u>Nitrobenzene (SIC 2861)</u> Heavy ends from purification column		K025 - Distillation bottoms from the production of nitrobenzene by the nitration of benzene (T)	950	2.5	Landfill 70	Secure Landfill 30	Incineration 2 100	
<u>Chlorobenzene (SIC 2869)</u> Heavy ends		K083 - Distillation bottoms from aniline production (T)	9,000+	172	Landfill 100		Incineration 2 100	
		K085 - Distillation or fractionating column bottoms from the production of chlorobenzenes (T)	6,000	44	Landfill 75	Secure Landfill 25	Incineration 2 100	

TABLE IV-8 (Continued)

Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practices	
		Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Characteristic Waste	Furfural (SIC 2865) Heavy ends, filter solids	60,000	600	Landfill 100		Secure Landfill 100	
Benzylchloride (SIC 2865) Still bottoms	K015 - Still bottoms from the distillation of benzylchloride (T)	45	1	Landfill 100		Secure Landfill 100	
Epichlorohydrin (SIC 2869) Heavy ends from fractionation	K017 - Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin (T)	7,800	53	Incineration 1 100		Incineration 2 100	
Ethanolamines (SIC 2869) Heavy ends		13,200	80	Secure Landfill 100		Incineration 2 100	
Fluorocarbons (SIC 2869) Spent reactor catalyst	K021 - Aqueous spent anionomyl catalyst waste from fluoromethanes production (T) Stripping still tails from the production of methyl ethyl pyridines (T)	68	0.22			Secure Landfill 100	
		700	38	Landfill 100		Secure Landfill 100	
K009 - Distillation bottoms from the production of acetaldehyde from ethylene (T)	K010 - Distillation side cuts from the production of acetaldehyde from ethylene (T)						
K022 - Distillation bottom tars from the production of phenol/acetone from cumene (T)							

TABLE IV-8 (Continued)

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practices	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Acrylonitrile (SIC 2869)		K023 - Distillation light ends from the production of phthalic anhydride from naphthalene (T)						
		K024 - Distillation bottoms from the production of phthalic anhydride from naphthalene (T)						
		K028 - Spent catalyst from hydrochlorinator reactor in the production of 1,1,1-trichloroethane (T)						
		K029 - Waste from the product stream stripper in the production of 1,1,1-trichloroethane (T)						
		K013 - Bottom streams from the acetonitrile column in the production of acrylonitrile (R, T)	53,000	490	Incineration 1 100		Incineration 1 100	
Heavy ends from the purification column		K014 - Bottoms from the acetonitrile purification column in the production of acrylonitrile (T)	2.3x10 ⁶	3,500 ^b	Deep Well Injection 90	Incineration 1 10	Deep Well Injection 90	Incineration 1 10
		K011 - Bottom streams from the wastewater stripper in the production of acrylonitrile (R, T)	2.3x10 ⁶	3,500 ^c	Deep Well Injection 90	POTW 10	Deep Well Injection 100	
		K012 - Still bottoms from the final purification of acrylonitrile in the production of acrylonitrile (T)	1,600	2	Incineration 1 100		Incineration 1 100	
			300	0.44	Landfill 100		Secure Landfill 100	
Wastewater Treatment Sludge			29,400	78	Incineration 1 100		Incineration 1 100	
Waste from the Purification of HCN								

TABLE IV-8 (Continued)

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practices	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %
Chloromethanes and Perchloroethylene (SIC 2869)	Wastewater treatment sludge		8,900	6		Landfill 100		Secure Landfill 100	
Heavy ends		K030 - Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene (T)	55,600	120		Landfill 31	Secure Landfill 47	Incineration 2 100	
		K016 - Heavy ends or distillation residues from the production of carbon tetrachloride (T)	205,300	159		Unlined Lagoon 100		Unlined Lagoon 100	
Aqueous scrubber waste									
Ethylchloride (SIC 2864)		K018 - Heavy ends from the fractionation in ethyl chloride production (T)	25,000	5		Landfill 100		Incineration 2 100	
Heavy ends									
Ethylene Dichloride/Vinyl Chloride (SIC 2869)	Aqueous scrubber wastes		4,777,000			Unlined Lagoon 100		Unlined Lagoon 100	
Vinyl chloride monomer, heavy ends		K020 - Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production (T)	93,900	38		Secure Landfill 50	Incineration 2 50	Incineration 2 100	
Ethylene dichloride, heavy ends		K019 - Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production (T)	8,700	10.4		Secure Landfill 50	Incineration 2 50	Incineration 2 100	

TABLE IV-8 (Continued)

Waste Type	Estimated Quantity Generated (1978 MT - wet)	Estimated Current Waste Management Practices		RCRA Management Practice	
		Practice %	Practice %	Practice %	Practice %
Characteristic Waste					
Wastewater treatment sludge	24,000	Secure Landfill 100		Incineration 2 100	
Filter wastes	7,100	Secure Landfill 50	Incineration 2 50	Incineration 2 100	
Total	10,058,000				

^aRate = metric tons waste/thousand metric tons of product.

^bAssumed 15% solids.

^cAssumed 2% solids.

Sources: TRW, Inc. "Assessment of Industrial Hazardous Waste Practices - Organic Chemicals, Pesticides, and Explosives Industries." Prepared for U.S. EPA. Estimates by Arthur D. Little, Inc.; Energy and Environmental Analysis, Inc.; Pope-Field Associates, Inc.; Temple, Barker and Sloane, Inc.

TABLE IV-9

HAZARDOUS WASTE GENERATION IN THE PESTICIDE INDUSTRY

Characteristic Waste Active Ingredient ^b (SIC 28664)	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practice	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Formulators Agricultural Chemicals, N.E.C. (SIC 2879)		K031 - Byproducts salts generated in the production of MSMA and cacodylic acid (T)	693,000	1,075 ^c	Landfill 100		Secure Landfill 100	
		K032 - Wastewater treatment sludge from the production of chlordane (T)						
		K033 - Wastewater and scrub water from the chlorination of cyclopentadiene in the production of chlordane (T)						
		K034 - Filter solids from the filtration of hexachlorocyclopentadiene in the produc- tion of chlordane (T)						
		K035 - Wastewater treatment sludges generated in the production of creosote (T)						
		K036 - Still bottoms from toluene recla- mation distillation in the production of disulfoton (T)						
		K037 - Wastewater treatment sludges from the production of disulfoton (T)						
		K038 - Wastewater from the washing and stripping of phorate production (T)						
		K039 - Filter cake from the filtration of diethylphosphorodithioic acid in the production of phorate (T)						
		K040 - Wastewater treatment of sludge from the production of phorate (T)						
		K041 - Wastewater treatment sludge from the production of toxaphene (T)						
		K042 - Heavy ends or distillation resi- dues from the distillation of tetrachloro- benzene in the production of 2, 4, 5-T (T)						
		K043 - 2, 6-Dichlorophenol waste from the production of 2, 4, D (T)						
			8,000	5.2 ^c	Landfill 100		Secure Landfill 100	
		Total	701,000					

^aRate = metric tons waste/thousand metric tons of product.^bListed rates do not include all hazardous wastes identified as active ingredients.^cAssumed 31% solids.Sources: TRW, Inc. "Assessment of Industrial Hazardous Waste Practices, Organic Chemicals, Pesticides, and Explosives Industries." Prepared for U.S. EPA.
Arthur D. Little, Inc., estimates.

TABLE IV-10

HAZARDOUS WASTE GENERATION IN THE COMMERCIAL EXPLOSIVES INDUSTRY

Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practice	
		(1978 MT - wet)	Rate ^a	Practice	%	Practice	%
Characteristic Waste		Total					
Commercial Explosives (SIC 2892)							
Scrap explosives and explosive-contaminated wastes from:							
	K044 - Wastewater treatment sludges from the manufacturing and processing of explosives (R)						
	K045 - Spent carbon from the treatment of wastewater containing explosives (R)						
	K046 - Wastewater treatment sludges from the manufacturing, formulation, and loading of lead-based initiating compounds (T)						
Fixed high explosives ^c		1,000	10 ^b	Open Burning	70	Unlined Lagoon	30
Blasting agents ^c		5,600	3.3 ^b	Open Burning	100	Incineration 1	100
Total		7,000					

^aRate = metric tons waste/thousand metric tons of product.^bAssumed 30% solids.^cListed wastes do not include all wastes identified as hazardous.

Sources: TRW, Inc. "Assessment of Industrial Hazardous Waste Practices, Organic Chemicals, Pesticides, and Explosives Industries." Prepared for U.S. EPA. Arthur D. Little, Inc., estimates.

TABLE IV-11

HAZARDOUS WASTE GENERATION IN THE PETROLEUM REFINING INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practices	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %
Petroleum Refining (SIC 2911)									
Once-through cooling water ^b sludge			110,700	0.14	Landfill 10	Secure Landfill 2	Dump 88	Secure Landfill 100	
Spent lime boiler feedwater ^b sludge			860,600	1.07	Landfill 42	Secure Landfill 30	Dump 28	Secure Landfill 100	
Exchange bundle cleaning sludge		K050 - Heat exchanger bundle cleaning sludge from the petroleum refining industry (T)	1,700	0.002	Landfill 34	Secure Landfill 26	Dump 40	Secure Landfill 100	
API separator sludge		K051 - API separator sludges from the petroleum refining industry (T)	312,500	0.39	Landfill 50	Secure Landfill 10	Dump 40	Secure Landfill 100	
Silt from storm water runoff			40,800	0.05	Landfill 24	Secure Landfill 2	Dump 74	Secure Landfill 100	
FCC catalyst fines			64,000	0.29	Landfill 30	Dump 70		Secure Landfill 100	
Coke fines			2,800	0.005	Landfill 80	Secure Landfill 20		Secure Landfill 100	
Cooling tower sludge			20,600	0.03	Landfill 80	Secure Landfill 10	Dump 10	Secure Landfill 100	
Slop oil emulsion solids		K049 - Slop oil emulsion solids from the petroleum refining industry (T)	46,800	0.06	Landfill 62	Secure Landfill 16	Land Treatment 22	Land Treatment 100	
Dissolved air flotation skimmings		K048 - Dissolved air flotation (DAF) float from the petroleum refining industry (T)	41,600	0.05	Landfill 11	Land Treatment 5	Dump 84	Land Treatment 100	

TABLE IV-11 (Continued)

Waste Type	Characteristic Waste	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practices		
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %	Practice %
Crude tank bottoms			1,000	0.001	Landfill 20	Land Treatment 23	Land Treatment 57	Land Treatment 100		
Lead tank bottoms		K052 - Tank bottoms (leaded) from the petroleum refining industry (T)	1,200	0.001	Landfill 62	Secure Landfill 38		Land Treatment 100		
Nonlead tank bottoms			154,700	0.19	Landfill 65	Land Treatment 35		Land Treatment 100		
Waste bio sludge			293,900	0.33	Landfill 65	Secure Landfill 20	Land Treatment 15	Land Treatment 100		
Total			1,925,000							

^aRate = metric tons waste/thousand metric tons of product (assuming 7.35 barrels/metric ton).

^bSome of the waste in this category may not be hazardous.

Sources: Jacobs Engineering Co., "Assessment of Hazardous Waste Practices in the Petroleum Refining Industry," Final Report for U.S. EPA, Office of Solid Waste Management Programs, Contract No. 68-01-2288, June 1976.
Arthur D. Little, Inc., estimates.

TABLE IV-12

HAZARDOUS WASTE GENERATION IN THE PETROLEUM REREFINING INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practices		
			Total	(1978 MT – wet) Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %	
<u>Petroleum Rerefining (SIC 2892)</u>										
Acid sludge			42,100	165	Landfill 100			Secure Landfill 100		
Caustic sludge			16,800	66	Landfill 100			Secure Landfill 100		
Spent clay			22,000	86	Landfill 100			Secure Landfill 100		
Total			81,000							

^aRate = metric tons waste/thousand metric tons of product.

Source: Swain, John W. Jr. "Assessment of Industrial Hazardous Waste Management Practices: Petroleum Rerefining Industry (SIC 2992)." Prepared for U.S. EPA, Office of Solid Waste, September 1976.
Arthur D. Little, Inc., estimates.

TABLE IV-13

HAZARDOUS WASTE GENERATION IN THE RUBBER PRODUCTS INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated (1978 MT - wat) Total	Estimated Current Waste Management Practices		RCRA Management Practice	
				Practice %	Practice %	Practice %	Practice %
Tires and Inner Tubes (SIC 3011)	Floor sweeping powder, dust from air pollution equipment		32,600	Landfill 100		Secure Landfill 100	
Other Rubber Products (SIC 3021, 3031, 3041, 3069)	Floor sweeping powder, dust from air pollution equipment		20,200	Landfill 100		Secure Landfill 100	
Total			53,000				

aRate = metric tons waste/thousand metric tons of product.

bRubber wastes are essentially dry.

Source: Foster D. Snell, Inc. "Assessment of Industrial Hazardous Waste Practices, Rubber and Plastics Industry: Chapter III: Rubber Products Industry (SIC 30)." Prepared for U.S. EPA, Office of Solid Waste Management, Contract No. 68-01-3194, March 1978.

Arthur D. Little, Inc., estimates.

TABLE IV-14

HAZARDOUS WASTE GENERATION IN THE LEATHER TANNING AND FINISHING INDUSTRY

Waste Type	Listed Waste	Estimated Quantity		Estimated Current Waste Management Practices		RCRA Management Practice	
		Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Characteristic Waste	Chrome Tanning Wastes Subcategory 1 (pulp hair)	419,400	610	Landfill 58	Land Treatment 42	Secure Landfill 100	
Subcategory 2 (save hair)	K053 - Chrome (blue) trimmings generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; through-the-blue; and shearling (T)	42,400	610	Landfill 100		Secure Landfill 100	
Nonchrome Tanning Wastes Subcategory 3	K054 - Chrome (blue) shavings generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; no beamhouse; through-the-blue; and shearling (T)	22,900	290	Landfill 28	Unlined Lagoon 72	Secure Landfill 100	
Retanning Wastes Subcategory 4	K055 - Buffing dust generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; and through-the-blue (T)	53,200	250	Landfill 100		Secure Landfill 100	
	K056 - Sewer screenings generated by the following subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/chrome tan/retan/wet finish; retan/wet finish; no beamhouse; through-the-blue; and shearling (T)						

TABLE IV-14 (Continued)

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practice	
			(1978 MT - wet) Total	Rate ^a	Practice %	Practice %	Practice %	Practice %
Chrome Tanning Wastes Subcategory 5 (no beamhouse)		K057 - Wastewater treatment sludges generated by the fol- lowing subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/ chrome tan/retan/wet finish; chrome tan/wet finish; no beam- house; through-the-blue and shearling (T)	27,600	130	Landfill 68	Unlined Lagoon 32	Secure Landfill 100	
Subcategory 6 (through- the-blue)		K058 - Wastewater treatment sludges generated by the fol- lowing subcategories of the leather tanning and finishing industry: hair pulp/chrome tan/retan/wet finish; hair save/ chrome tan/retan/wet finish; and through-the-blue (R, T)	58,300	510	Landfill 100		Secure Landfill 100	
Chrome Tanning Wastes Subcategory 7 (shearlings)		K059 - Wastewater treatment sludges generated by the fol- lowing subcategory of the leather tanning and finishing industry: hair save/non-chrome tan/retan/wet finish (R)	4,100	170	Landfill 100		Secure Landfill 100	
Leather Finishing Wastes Subcategory 8			300	0.06	Landfill 91	Incineration 3 9	Secure Landfill 100	
Total			628,000					

^aRate = metric tons waste/thousand metric tons of product (1,000 hides = 25 metric tons).

Sources: SCS Engineers, Inc. "Assessment of Industrial Hazardous Waste Practices - Leather Tanning and Finishing Industry." Prepared for U.S. EPA, Office of Solid Waste Management Programs, Hazardous Waste Management Division, Contract No. 68-01-3281, February 1976.
Estimates by Arthur D. Little, Inc.; Development Planning and Research Associates, Inc.; Pope-Reid Associates, Inc.

TABLE IV-15

HAZARDOUS WASTE GENERATION IN THE FERROUS METAL SMELTING AND REFINING INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practice		
			Total	(1978 MT - wet)	Practice %	Practice %	Practice %	Practice %	Practice %	Practice %
Primary Iron and Steel (SIC 3312)										
Combined dusts and sludges from iron and steel production		K061 - Emission control dust/sludge from the electric furnace production of steel (T)	415,000	0.9	Landfill 30	Unlined Lagoon 70		Lined Lagoon 70	Secure Landfill 30	
Tin plating sludge			33,000	5.32	Landfill 30	Unlined Lagoon 70		Lined Lagoon 70	Secure Landfill 30	
Decanter tank tar		K087 - Decanter tank tar/sludge from coking operations (T)	28,000		Landfill 30	Unlined Lagoon 70		Lined Lagoon 70	Secure Landfill 30	
Dephenolizer sludge		Caustic neutralization waste from coke production (C)								
Ammonia still lime sludge		K060 - Ammonia still lime sludge from coking operations (T)	28,000	0.93	Landfill 30	Unlined Lagoon 70		Lined Lagoon 70	Secure Landfill 30	
Galvanizing sludge and pickling sludge		K062 - Spent pickle liquor from steel finishing operations (C, T)	449,000		Landfill 30	Unlined Lagoon 70		Lined Lagoon 70	Secure Landfill 30	
Miscellaneous solid wastes from coke ovens		K063 - Sludge from lime treatment of spent pickle liquor from steel finishing operations (T)	74,000		Landfill 100			Secure Landfill 100		
Ferroalloys (SIC 3313)										
Ferromanganese dusts and sludges		K092 - Emission control dust or sludge from ferromanganese production (T)	80,000		Landfill 20	Unlined Lagoon 80		Secure Landfill 20	Lined Lagoon 80	

TABLE IV-15 (Continued)

Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practices		
		(1978 MT – wet) Total	Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %	
Characteristic Waste									
Ferrochrome dusts and sludges	K091 – Emission control dust or sludge from ferrochromium production (T)	18,000		Landfill 20	Unlined Lagoon 80	Secure Landfill 20	Lined Lagoon 80		
Ferrochrome silicon dusts and sludges	K090 – Emission control dust or sludge from ferrochromium-silicon production (T)	10,000		Landfill 20	Unlined Lagoon 80	Secure Landfill 20	Lined Lagoon 80		
Ferrous Foundries (SIC 32)									
Lead dust and sludge from furnace emissions	Lead-bearing wastewater treatment sludges from gray iron foundries (Deferred)	128,000 ^b		Dump 97	Unlined Lagoon 3	Secure Landfill 100			
Total		1,203,000							

aRate = metric tons waste/thousand metric tons of product.

bProvisional estimate, regulations are not yet finalized.

Sources: Calspan Corp., "Assessment of Industrial Hazardous Waste Practices in the Metal Smelting and Refining Industry, Volume III: Ferrous Smelting and Refining." Prepared for U.S. EPA, Office of Solid Waste Management Programs, Contract No. 68-01-2604, April 1977.

Arthur D. Little, Inc., estimates.

TABLE IV-16

HAZARDOUS WASTE GENERATION IN THE NONFERROUS METAL SMELTING AND REFINING INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practice	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Primary Copper: Smelting and refining acid plant sludge and wastewater treatment sludge		Primary Copper: K064 - Acid plant blowdown slurry/sludge resulting from the thickening of blowdown slurry from primary copper production (T)	200	0.1 ^b	Dump 80	Landfill 20	Secure Landfill 100	
Electrolyte refining residues		Emission control dust/sludge from reverberatory furnace and converters from primary copper production (Proposed)	4,240	2 ^c	Dump 80	Landfill 20	Secure Landfill 100	
			0		Recycle 100		Recycle 100	
Primary Lead: Wastewater treatment sludge, including lagoon dredging from smelter		Primary Lead: K065 - Surface impoundment solids contained in and dredged from surface impoundments at primary lead smelting facilities (T)	38,000		Recycle 40	Dump 40	Secure Landfill 60	Recycle 40
Primary Zinc Electrolytic Leaching residue filter cake		K067 - Electrolytic anode slimes/sludges from primary zinc production (T)	115,000	483 ^d	Landfill 20	Dump 80	Secure Landfill 100	
Wastewater treatment sludge (including acid plant sludge and slimes)		K066 - Sludge from treatment of process wastewater and/or acid plant blowdown from primary zinc production	14,800	62 ^b	Landfill 20	Dump 80	Secure Landfill 100	

TABLE IV-16 (Continued)

Waste Type	Characteristic Waste	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practice	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %
Characteristic Waste	Cadmium plant residues	K068 - Cadmium plant leach residue (iron oxide) from primary zinc production	480	2 ^b	Dump 75	Sanitary Landfill 25		Secure Landfill 100	
			12,800	76 ^b		Dump 100		Secure Landfill 100	
Primary Zinc (Pyrolytic)	Wastewater treatment sludge (including acid plant sludge, cadmium plant residues)	K088 - Spent potliners (cathodes) from primary aluminum production (T)	192,600		Reprocess 60	Landfill 10	Dump 30	Reprocess 100	
			260,000		Landfill 25		Secure Landfill 75	Secure Landfill 100	
Primary Aluminum	Pot Liners								
Wastewater treatment sludge									
Primary Antimony	Electrolytic sludge		280	700	Unlined Lagoon 100			Lined Lagoon 100	
			630		Landfill 100			Secure Landfill 100	
Secondary Copper	Wastewater treatment sludge								

TABLE IV-16 (Continued)

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices			RCRA Management Practice		
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %	Practice %	Practice %
Secondary Lead										
Battery cracking waste-water treatment sludge (including SO ₂ scrubber sludge and white metal furnace dust leaching solution)		K069 - Emission control dust/sludge from secondary lead smelting (T)	100,000	37.5 ^b	Recycle 75	Landfill 5	Land Treatment 20	Recycle 80	Land Treatment 20	
Battery casings (from battery cracking plastic and rubber)			10,800	20 ^f	Landfill 100			Secure Landfill 100		
Total			750,000							

^aRate: metric tons waste/thousand metric tons of product.

^bAssumed 20% solids.

^cAssumed 10% solids.

^dAssumed 67% solids.

^eAssumed 40% solids.

^fDry.

Sources: Calpan Corp. "Assessment of Industrial Hazardous Waste Practices in the Metal Smelting and Refining Industry: Primary and Secondary Non-Ferrous Smelting and Refining: Volume II." Technical Report to U.S. EPA, Office of Solid Waste, Contract No. 68-01-2604, April 1977.
Estimates by Arthur D. Little, Inc.; Pope-Reid Associates, Inc.; Sverdrup and Parcel Associates, Inc.

TABLE IV-17

HAZARDOUS WASTE GENERATION IN THE ELECTROPLATING AND METAL FINISHING INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated (1978 MT - wet) Total	Estimated Current Waste Management Practices		RCRA Management Practice	
				Practice %	Practice %	Practice %	Practice %
Job Shops ^b Wastewater treatment sludge from: common and precious metals plating, electroless plat- ing, conversion coating, ano- dizing, and printed circuit boards. Process waste materials and degreaser sludges		F006 - Wastewater treatment sludges from electroplating operations (T)	125,000	Landfill 100		Secure Landfill 100	
		F007 - Spent plating bath solu- tions from electroplating opera- tions (R, T)					
		F008 - Plating bath sludges from the bottom of plating baths from electroplating operations (R, T)	2,500 ^d	Landfill 100		Secure Landfill 100	
		F009 - Spent stripping and cleaning bath solutions from electroplating operations (R, T)					
Captives ^f Wastewater treatment sludge from: common and precious metals plating, electroless plat- ing, conversion coating, ano- dizing, and printed circuit boards. Process waste materials and degreaser sludges		F006, F007, F008, F009 (See above)	1.8 x 10 ⁶	Landfill 100		Secure Landfill 100	
			36,000 ^d	Landfill 100		Secure Landfill 100	
		Total	1,997,000				

a. Rate = metric tons waste/thousand square meters of product.

b. Assuming 2402 job shops with mean water flow of 44,000 gal/day.

c. Assumed 20% solids.

d. Assumed to be 2% of wastewater treatment sludge.

e. Assumed dry.

f. Assuming 6077 captives with mean water flow of 227,000 gal/day.

Sources: Battelle Columbus Laboratories. "Assessment of Industrial Hazardous Waste Practices - Electroplating and Metal Finishing Industries - Job Shops." Final Report to U.S.

EPA, Office of Solid Waste, Hazardous Waste Management Division, Contract No. 68-01-2664, September 30, 1976.

Estimates by Arthur D. Little, Inc., Booz-Allen and Hamilton, Inc., Hamilton Standard, Inc.

TABLE IV-18

HAZARDOUS WASTE GENERATION IN THE SPECIAL MACHINERY MANUFACTURING INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practice	
			(1978 MT - wet) Total	Rate ^a	Practice %	Practice %	Practice %	Practice %
Special Industry Machinery (SIC 355) Machine shop wastes		F010 - Quenching bath sludge from oil baths from metal heating treating operations (R,T) F011 - Spent solutions from salt bath pot cleaning from metal heat treating operations (R,T)	20,000	1.1	Landfill 100		Secure Landfill 80	Incineration 3 20
Heating treating wastes		F012 - Quenching wastewater treatment sludges from metal heat treating operations (T)	8,300	2.00	Landfill 100		Secure Landfill 100	
Electroplating wastes - wastewater treatment sludges and solvent sludges		F006, F007, F008, F009 (See Electroplating)	4,200	2.5	Landfill 100		Secure Landfill 100	
Paint waste			10,000	1.05	Landfill 100		Incineration 3 90	Secure Landfill 10
Office, Computing and Accounting Machinery (SIC 357) Machine shop wastes		F010, F011, F012 (See above)	6,500	1.1	Landfill 100		Incineration 3 90	Secure Landfill 10
Heating treating wastes		F006, F007, F008, F009 (See Electroplating)	6,200	2.0	Landfill 100		Incineration 3 90	Secure Landfill 10
Electroplating wastes - wastewater treatment sludges and solvent sludges		Paint waste	18,000	2.5	Landfill 100		Incineration 3 90	Secure Landfill 10
Total			1,100	1.05	Landfill 100		Incineration 3 90	Secure Landfill 10
			74,000					

a. Rate = metric ton/year/production employee in plants producing the specified waste

Sources: Wapora, Inc., "Assessment of Industrial Hazardous Waste Practices, Special Machines Manufacturing Industries." Prepared for U.S. EPA, Office of Solid Waste Management Programs, February 1976.
Arthur D. Little, Inc., estimates.

TABLE IV-19

HAZARDOUS WASTE GENERATION IN THE ELECTRONIC COMPONENT INDUSTRY

Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practice	
		Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Characteristic Waste							
Electronic Components (SIC 367)							
Halogenated solvents		8,300	1.84	Landfill 100		Incineration 2 100	
Nonhalogenated solvents		24,800	5.53	Landfill 100		Incineration 1 100	
Wastewater treatment sludges		58,000	12.9	Landfill 100		Secure Landfill 100	
Oils		3,500	0.77	Landfill 100		Incineration 2 50	Secure Landfill 50
Paint wastes		400	0.08	Landfill 100		Secure Landfill 100	
Total		91,000					

^aRate = metric tons/year/plant; assumed 4,500 plants in industry.

Sources: Wapora, Inc. "Assessment of Industrial Hazardous Waste Practices: Electronic Components Manufacturing Industry." Prepared for U.S. EPA, Hazardous Waste Management Division, Contract No. 68-01-3193, February 13, 1976.

Wapora, Inc. "Assessment of Industrial Hazardous Waste Practices: Electronic Components Manufacturing Industry." Draft Report for U.S. EPA, Hazardous Waste Management Division, Contract No. 68-01-3193, March 22, 1976.

Wapora, Inc. "Assessment of Industrial Hazardous Waste Practices: Electronic Components Manufacturing Industry." Prepared for U.S. EPA, Hazardous Waste Management Division, Contract No. 68-01-3193, January 1977.

Arthur D. Little, Inc., estimates.

TABLE IV-20

HAZARDOUS WASTE GENERATION IN THE BATTERY INDUSTRY

Characteristic Waste	Waste Type	Listed Waste	Estimated Quantity Generated		Estimated Current Waste Management Practices		RCRA Management Practice	
			Total	(1978 MT - wet) Rate ^a	Practice %	Practice %	Practice %	Practice %
Storage Batteries (SIC 3691)								
Lead/Acid - wastewater treatment sludge from lime neutralization		Lead acid storage battery production - wastewater treatment sludges (T) (Deferred)	440,000 ^b	1,201 ^c	Landfill 100		Secure Landfill 100	
Lead/Acid - wastewater treatment sludge from NaOH neutralization		Clean-up wastes from cathode and anode paste production in the production of lead acid storage batteries (T) (Deferred)	450 ^b	0.5 ^d	Landfill 30	POTW 65	Secure Landfill 5	
Wastewater treatment sludge and manufacturing scrap (from other storage batteries)		Wastewater treatment sludges from the production of nickel cadmium batteries (T) (Deferred)	0		Recycle 100			
Primary Batteries ^f (SIC 3662)								
Wastewater treatment sludge and manufacturing scrap			1,600	10.0	Landfill 100		Secure Landfill 100	
Total			442,000					

^aRate = metric tons waste/thousand metric tons of product.^bAssumed 20% of production uses lime treatment, 80% uses NaOH treatment.^cAssumed 35% solids.^dAssumed 80% solids.^eDischarged to publicly owned treatment works.^fIncludes carbon/zinc, air cell, alkaline/manganese, magnesium carbon, mercury, and lead/acid reserve batteries.

Sources: Versar, Inc. "Assessment of Industrial Hazardous Waste Practices - Battery Industry." Prepared for U.S. EPA, Hazardous Waste Management Division. Arthur D. Little, Inc., estimates.

HAZARDOUS WASTE GENERATION IN THE DRUM RECONDITIONING INDUSTRY

aRate = metric tons waste/thousand metric tons of active ingredients.

Sources: Energy Resources Co., Inc. "Economic Impact Analysis of Waste Management Regulations on Selected Generating Industries." Prepared for U.S. EPA, December 1978.

Arthur D. Little, Inc., estimates.

TABLE IV-22

HAZARDOUS WASTE GENERATION IN THE CHEMICAL WHOLESALING INDUSTRY

Waste Type	Listed Waste	Estimated Quantity Generated (1978 MT. - wet) Total	Estimated Current Waste Management Practices		RCRA Management Practice	
			Practice %	Practice %	Practice %	Practice %
Characteristic Waste						
Chemical Wholesaling (SIC 5161)						
Repackaging Wastes		5,000		Landfill 100		Secure Landfill 100
Total		5,000				

^aRate = metric tons waste/thousand metric tons of active ingredients.

Sources: Energy Resources Co., Inc. "Economic Impact Analysis of Waste Management Regulations on Selected Generating Industries," Prepared for U.S. EPA, December 1978.

Arthur D. Little, Inc., estimates.

The wastewater treatment sludge quantities to be produced after pretreatment and best available technology economically achievable (BATEA) effluent guidelines are promulgated in 1980-81 were estimated for each industry, using inputs from EPA's effluent guideline contractors and project officers. These waste quantities were added to the other hazardous waste produced in 1978.

The rate of waste generation is given in metric tons (MT) of waste per thousand MT of production for most industries. Some industries, however, use a different base, which is indicated as a footnote to the appropriate table.

The waste quantity is generally stated as wet weight, because this is the quantity related to disposal capacity and the cost of disposal. Waste for land disposal is most often stated in terms of 20% solids content volume. In this condition the waste is nonflowing and suitable for land disposal. Footnotes to individual tables indicate whether the waste is dry or has a different percentage of solids (other than 20%). Waste discharged to surface impoundments is stated in the flowing condition of its discharge to the impoundment.

Most of the subtotals for individual wastes are rounded to two significant figures, reflecting the accuracy of the data available. Subtotals for each industry segment in individual tables are rounded to the nearest thousand MT.

The disposal practices identified include:

- Open dump, including piles.
- Landfill, i.e., sanitary landfill.
- Secure landfill, i.e., landfill meeting RCRA standards.
- Unlined lagoons and lined lagoons (for the disposal of liquids and sludges). Lined lagoons are assumed to meet RCRA standards. The term lagoon is synonymous with the term surface impoundment.
- Land treatment (synonymous with land spreading or land farming).
- POTW, i.e., discharge of liquid waste or sludge to a publicly owned treatment works for sanitary waste.
- Incineration has three subcategories:
 - 1) a simple liquid incinerator used for hydrocarbons
 - 2) a liquid incinerator with a scrubber for halogenated hydrocarbons
 - 3) a rotary kiln for the incineration of solids and sludges, especially those that may leave toxic residues, such as heavy metals.

- Ocean disposal.
- Deep well injection.

The current distribution of waste management practice estimates was derived from the original industry assessment reports. Practices have been continuously upgraded since the period covered by these reports in anticipation of RCRA regulations and because of increased concern over hazardous wastes in general. The data reported in the tables have been updated and are considerably changed from those data pertaining when the work was initiated and from the practices listed in the original industry assessment reports. The updating of disposal data results in the inclusion within the baseline of some practices that have been adopted in anticipation of RCRA prior to the effective date of these regulations. Even the revised estimates are likely to be somewhat out of date at the final publication of this report as industries continue to modify their disposal practices toward the objectives sought in RCRA.

The estimates of current waste management practices (center column) were used in the incremental compliance cost analysis. It was assumed that no significant change in disposal and treatment practice would take place as a result of the ISS regulations; significant changes toward the disposal pattern shown in the right-hand column of the tables would occur only after the facility permitting regulations applicable to TSDFs were promulgated.

The far right columns in the tables contain estimates of the distribution of waste management practices that were expected to result from implementing the set of RCRA regulations proposed in December 1978. Arthur D. Little, Inc., prepared these estimates. Any changes in the regulations actually promulgated in the future could render these estimates obsolete and they have not been used in this analysis of the ISS.

B. WASTE GENERATION DATA SUMMARY AND DISCUSSION

1. Industry Totals

In 1978, the segments of the 22 industries studied generated about 26.2 million MT of hazardous waste (see Table IV-23). This quantity is generated by 51,000 manufacturing and service facilities. The average waste generation per plant is 514 MT per year. Fully one-half of the plants generate less than 12 MT per year (see Table IV-24) and fall into a special category, small waste generators, discussed below.

Included in the 26.2 million MT total are 7.8 million MT that are recycled, injected into deep wells, or dumped in the ocean. Although wastes managed by these techniques are covered in whole or in part by the regulations, disposal costs are not changed significantly by the ISS and therefore do not contribute to RCRA incremental costs. For this reason, these wastes have not been included in the cost-of-compliance analysis. The remaining 18.4 million MT are defined in this report as

TABLE IV-23

ESTIMATE OF HAZARDOUS WASTE GENERATED BY 22 MANUFACTURING INDUSTRIES - 1978

SIC Code	Industry	Hazardous Waste Generation		% to Off-Site Disposal ISS-Regulated Waste ^b	Number of Plants		ISS-Regulated Waste per Plant ^b (MT)
		Total ^a	(000 MT/yr) ISS-Regulated Waste ^b		Total	With ISS-Regulated Waste ^b	
0711,0721,0729	Agricultural Services	466	336	99	22,700	16,342	21
22	Textile Manufacturing	224	220	34	1,173	555	396
2491	Wood Preserving	4	4	100	458	458	88
281	Inorganic Chemicals	6,618 ^c	3,566	9	112	111	32,126
282	Plastics	562	562	49	571	571	984
283	Pharmaceuticals	116	116	70	1,240	1,240	94
285	Paint & Allied Products	114	104	100	1,500	1,375	76
286	Organic Chemicals ^d	10,058 ^e	5,657	6	118	113	50,062
28694,2879	Pesticides	701	701	13	530	530	1,323
2892	Explosives	7	-	-	95	-	0
2911	Petroleum Refining	1,925	1,925	25	285	285	6,754
2992	Petroleum Rerefining	81	81	34	23	23	3,522
30	Rubber Products	53	53	98	1,710	1,710	31
3111	Leather Tanning	628	628	51	273	267	2,362
331,332	Ferrous Metals	1,203	1,203	25	1,132	1,132	1,063
333,334	Nonferrous Metals	750	536	7	255	83	6,458
347	Electroplating	1,997	1,997	35	7,307	7,307	273
355,357	Special Machinery (office/computing)	74	74	100	3,120	3,120	24
367	Electronic Components	91	91	99	4,300	4,300	21
3691	Batteries	442	441	44	263	263	1,676
5085	Drum Reconditioning	74	74	100	200	200	370
5161	Chemical Wholesaling	5	5	100	3,400	3,400	15
	Total	26,193	18,374	20	50,765	43,384	424

a. Data from the segments studied, not necessarily the total quantity of hazardous waste generated by these industries.

b. Does not include waste that is recycled, injected into deep wells, or disposed of in the ocean.

c. Includes 2.7 million metric tons of hazardous waste disposed of by ocean disposal and deep well injection.

d. Data represent the 14 product segments studied, not the total volume of hazardous waste from the Organic Chemical industry.

e. Includes 4.4 million metric tons of dilute aqueous wastes in two product segments that are disposed of by deep well injection.

Source: Arthur D. Little, Inc., estimates.

TABLE IV-24

**DISTRIBUTION OF WASTE GENERATING PLANTS
IN 22 SELECTED INDUSTRIES BY VOLUME**

Hazardous Waste Generation Category	Number of Plants		Hazardous Waste Volume (000 MT/yr)	
	Total	With ISS Waste ^a	Total	With ISS Waste ^a
Greater than 1000 kg/month	26,409	21,990	26,083	18,285
Less than or equal to 1000 kg/month	<u>24,356</u>	<u>21,394</u>	<u>110</u>	<u>89</u>
Total	50,765	43,384	26,193	18,374

a. Excludes waste disposed of in deep wells, by ocean disposal, or recycled.

Source: Arthur D. Little, Inc., estimates.

the ISS-regulated wastes generated by the 22 industries included in the analysis. The ISS waste so defined is produced by 43,400 plants with an average of 424 MT per year per plant.

The organic chemical, inorganic chemical, electroplating, petroleum refining, and ferrous metal industries are the largest generator industries. Plants in the organic chemical industry are the largest generators, with an average of about 50,000 MT/year per plant, and plants in the chemical wholesaling industry are the smallest, with 1.5 MT per year per plant.

The largest waste generator sector is the chemical industry, with about 17 million MT of waste annually (10 million MT from the organic chemical industry and 7 million MT from the inorganic chemical industry). Allied industry categories in SIC 28, i.e., plastic materials, synthetic rubbers, and synthetic fibers; pharmaceuticals; paint and allied products; pesticides; and commercial explosives, contribute an additional 1.5 million MT.

Petroleum refining contributes 2 million MT and electroplating and metal finishing another 2 million MT. About 94% of the electroplating total is generated by captives,* which are part of other industries not included in the analysis. The remaining 6% of electroplating waste is generated by independent job shops.*

Quantities of hazardous waste from the ferrous metal and ferroalloy production industry, including iron and steel production, ferrous foundries, and ferroalloy production, are estimated to be 1.2 million MT annually. The nonferrous metal smelting and refining industry generates 0.8 million MT annually. Several other industries also produce substantial amounts of waste: leather tanning and finishing, 0.6 million MT; plastics, 0.6 million MT; agricultural services, 0.5 million MT; batteries, 0.4 million MT; and textile manufacturing, 0.2 million MT. The remaining industries together total 0.6 million MT.

In addition to the wastes from the industries covered in this report, large volumes of wastes are produced from other industries, e.g., phosphate mining, phosphoric acid and elemental phosphorus production, and metal mining. The total waste from the first three operations is estimated to be 140 million MT, of which 90 million MT comes from phosphate mining and is either dumped or confined in unlined lagoons. Fifty million MT of waste from phosphoric acid and elemental phosphorus production are stockpiled for eventual reuse. Large quantities of mine tailings, which may have hazardous characteristics, are also generated; the total may be close to 1.0 billion MT annually, with a large fraction occurring in the production of copper and uranium.

These industries and the wastes they produce are not included in the analysis presented here because the wastes have not been demonstrated to be hazardous or because their regulation has been postponed. Cement production, pulp and paper production, oil and gas drilling and production, and electric utilities are also not included for the same reasons.

*For a definition of "captives" and "job shops" see Appendix F (Electroplating).

2. Small Waste Generators

In an attempt to ameliorate a significant economic impact on small business and a potentially large administrative burden on EPA and the state regulatory agencies, EPA has excluded small waste generators (SWGs) from compliance with most parts of the standards for generators, although they must dispose of their wastes at sites with interim status, RCRA permits, or state approval. SWGs are defined in the current regulation as generators producing less than 1000 kg/month (12 MT/year) of hazardous waste.*

Of the 43,400 plants generating ISS-regulated waste, approximately 21,400 (49%) produced less than 12 MT/year in 1978 (Table IV-24). The SWGs produced approximately 110,000 MT of waste, of which 89,000 MT was ISS-regulated. The ISS-regulated SWGs generated an average 4.2 MT/year.

The distribution of plants and waste volumes within the SWG category is shown in Table IV-25. Proposals have been made to lower the SWG level from 12 MT/year to 6 MT/year and to 1.2 MT/year. If the level were set at 6 MT/year, approximately 25% fewer generators would be included in the SWG group and almost 50% less waste. A cut-off level of 1.2 MT would remove about 75% of the plants from the current SWG group and subject 97% of the waste to RCRA controls.

3. Comparison With Other Estimates of Waste Generation

The estimated 26 million MT of hazardous waste generated by the 22 industries is about the same as that reported in the Draft Economic Impact Analysis accompanying the proposed RCRA regulations in 1979.** The composition of the estimates differs for four reasons:

- 1) Some wastes included in the previous report are no longer considered hazardous under present EPA definitions and, conversely, other wastes not previously listed as hazardous are now included.
- 2) The estimated quantities of previously identified wastes were revised to reflect improved information on waste generation rates and to correspond to 1978 production levels.
- 3) Wastewater treatment sludges from BATEA and pretreatment regulations were re-estimated in light of more current information on treatment technology.
- 4) Industries were added to the analysis that had not previously been included (wood preserving, agricultural services, captive electroplating, drum reconditioning, and chemical wholesaling).

*The exclusion is 1 kg/month for certain listed chemicals.

**Arthur D. Little, Inc., "Draft Economic Impact Analysis Subtitle C, Resource Conservation and Recovery Act of 1976, Regulatory Analysis Supplement," prepared for U.S. EPA, Office of Solid Waste, January 1979.

TABLE IV-25

SMALL WASTE GENERATOR SUMMARY

Small Waste Generator Category									
SIC Code	Industry	Less Than or Equal to 100 kg/Month ^a (1.2 MT/year)		Less Than or Equal to 500 kg/Month ^a (6 MT/year)		Less Than or Equal to 1000 kg/Month ^a (12 MT/year)		Total Industry	
		No. of Plants	Total Waste (MT)	No. of Plants	Total Waste (MT)	No. of Plants	Total Waste (MT)	No. of Plants	Total Waste (MT)
Total All Industries									
0711,21,29	Agricultural Services	5,773	3,273	19,086	53,734	24,356	110,484	50,765	26,193,000
22	Textile Manufacturing	500	470	6,500	33,000	10,300	72,100	22,700	466,000
2491	Wood Preserving	36	88	83	130	116	300	1,173	224,000
281	Inorganic Chemicals	100	75	254	620	324	1,206	458	4,200
282	Plastics	0	0	3	17	7	47	112	6,618,000
283	Pharmaceuticals	140	32	349	720	353	754	671	562,000
285	Paint and Allied Products	807	170	970	450	1,057	929	1,240	116,000
286	Organic Chemicals	0	0	230	960	400	2,879	1,500	114,000
28694,2879	Pesticides	0	0	2	6	10	68	118	10,058,000
2892	Explosives	71	57	223	460	287	879	530	701,000
2911	Petroleum Refining	10	18	34	120	43	277	95	6,600
2992	Petroleum Rerefining	0	0	1	4.3	0	0	285	1,925,000
30	Rubber Products	0	0	0	0	0	0	23	81,000
3111	Leather Tanning	490	230	960	1,700	1,140	3,420	1,710	53,000
331,332	Ferrous Metals	20	7.6	45	95	70	220	273	628,000
333,334	Nonferrous Metals	0	0	19	67	158	1,321	1,132	1,203,000
347	Electroplating	6	5.3	12	34	17	89	255	750,000
355,357	Special Machinery	899	390	2,039	3,400	1,424	5,355	7,307	1,997,000
367	Electronic Components	630	400	1,490	2,900	2,123	6,370	3,119	74,000
369	Batteries	1,200	500	2,450	4,000	3,099	9,296	4,300	91,000
5085	Drum Reconditioning	14	9	22	51	28	84	263	442,000
5161	Chemical Wholesaling	0	0	0	0	0	0	200	74,000
		850	900	3,400	5,000	3,400	5,000	3,400	5,000

a. May not include most current data on textile, organic chemical, leather tanning and nonferrous metal industries.

Source: Arthur D. Little, Inc., estimates.

The data on waste generation used for this analysis are the best now available, but there are probably omissions and errors resulting from deficiencies in the underlying data base. Other estimates (by MITRE Corporation, Battelle Columbus Laboratories, and TRW, Inc.) of the total quantities of hazardous waste being generated also differ from those in Table IV-23. Inconsistencies are to be expected, partly from differences in assessment methodology and partly from the use of entirely different data bases. There are also differences in each author's definition of "hazardous waste." The working definition for this study conforms as closely as possible to that of the promulgated ISS regulations.

The estimates published by MITRE, Battelle, and TRW have been summarized and rearranged in Table IV-26 to facilitate comparison with the results of this study. Overall, the studies show reasonable agreement and some of the differences are readily explained. Battelle's estimates and Arthur D. Little's estimates are derived from the same data base, i.e., the industry assessment studies. The subtotal for major manufacturing segments in the Battelle estimate is about the same as that in this study, but differs in detail. For example, the lower quantity now estimated for the metal smelting and refining industry is a result of deleting many wastes that were originally included, but are no longer classified as hazardous by EPA. Arthur D. Little's estimate for chemicals is higher than Battelle's because a number of large-volume aqueous wastes have now been added. The total for chemicals may still be too low, however, because many segments of the industry were outside the scope of this study. Conversely, the MITRE and TRW estimates from the chemical industry may include wastes from phosphate mining, which Arthur D. Little has identified separately. TRW's estimate from other manufacturing includes 15 million MT from transportation and more than 3 million MT from the pulp and paper industry. It is still uncertain how much of this waste will ultimately be classified as hazardous. Some of the apparent discrepancies in the total waste quantities may be due to differences in how the waste solids are reported.

C. WASTE MANAGEMENT

Table IV-27 summarizes the current waste management practice data presented above in Tables IV-1 through IV-22. Land-based hazardous waste disposal practices accounted for 70% of total waste management in 1978. Only 6% of the waste was sent to secure landfills that may meet upcoming standards for TSDFs. About 5% is presently dumped in uncovered disposal sites and about 3%, mostly materials in the ferrous and nonferrous metal industries, is in storage or held for reprocessing.

Dumps are identified as a current (pre-November 1980) waste management practice, although open dumping is no longer an acceptable disposal method. This convention is consistent with the data sources from which the waste generation and disposal practice estimates are derived. The compliance activities and costs are treated essentially in the same way as for sanitary landfills, although a slightly lower price is used for off-site disposal in dumps than in landfills. Post-RCRA ISS waste practices will eliminate the use of dumps altogether. This analysis assumes that dump sites would follow the procedures specified for compliance with the ISS.

TABLE IV-26
COMPARISON OF HAZARDOUS WASTE GENERATION ESTIMATES
(million MT/yr [wet basis])

Industries	MITRE (1975) ^a	Battelle (1977) ^b	TRW (1979) ^c	ADL (1979) ^e	ADL (1981)
Major Manufacturing Segments					
Chemicals	28.7	5.9 ^d	18.0	16.0 ^d	16.6 ^d
Petroleum	1.0	1.5	0.8	2.0	2.0
Metal Smelting	3.8	13.8	5.3	2.0	2.0
Six Other Manufacturing Industries	7.6	3.4	11.3	3.6	5.1
Subtotal	41.1	24.6	35.4	23.6	25.7
Other Manufacturing Industries	6.4	NI	21.0	NI	NI
Non Manufacturing Industries	NI	NI	2.4	0.6	0.5
Total	47.5	24.6	58.8	24.2	26.2

a. MITRE Corporation, "Subtitle C, Resource Conservation & Recovery Act 1976," Draft EIS, U.S. EPA, January 1979.

b. Battelle Columbus Laboratories, "Cost of Compliance with Hazardous Waste Management Regulations," Draft Report to U.S. EPA, Contract 68-01-4360, May 1978.

c. TRW, Inc. "Technical Environmental Impacts of Various Approaches for Regulating Small Volume Hazardous Waste Generators." Report to U.S. EPA, Contract 68-02-2613, December 1979.

d. Understates total hazardous waste volume because many products in Inorganic Chemicals and Organic Chemicals were outside the scope of this study.

e. Arthur D. Little, Inc., "Draft Economic Impact Analysis, Subtitle C. Resource Conservation and Recovery Act of 1976," Report to U.S. EPA, Contract 68-01-4671, January 1979.

TABLE IV-27

HAZARDOUS WASTE MANAGEMENT PRACTICES FOR
22 MANUFACTURING INDUSTRIES - 1978

Waste Management Practices	Quantity (Million MT/Year)	Distribution (%)
Sanitary Landfill	7.6	29.0
Secure Landfill	1.6	6.1
Dump	1.3	5.0
Unlined Impoundment	6.9	26.3
Incineration ^a	0.6	2.3
Land Treatment	<u>0.4</u>	<u>1.5</u>
Subtotal	18.4	70.2
Recycle	0.8	3.1
Ocean Disposal	1.9	7.2
Deep Well Injection ^b	<u>5.1</u>	<u>19.5</u>
Subtotal	7.8	29.8
Total	26.2	100.0

a. Includes 6000 metric tons from the explosives industry disposed of by open burning.

b. Includes 8.4 million metric tons of dilute wastes from organic chemicals and 0.8 million metric tons of waste from inorganic chemicals disposed of by deep well injection.

Source: Arthur D. Little, Inc., estimates.

Twenty-six percent of the total waste is disposed of in unlined surface impoundments that may be a potential source of groundwater contamination. Although these impoundments are used widely by industry, most of those identified are treatment/storage impoundments and were not identified in the EPA surface impoundment assessment as disposal facilities. Because of the expense in removing waste from an impoundment for land disposal elsewhere, much of the waste in treatment/storage impoundments may remain in the impoundments for final disposal.

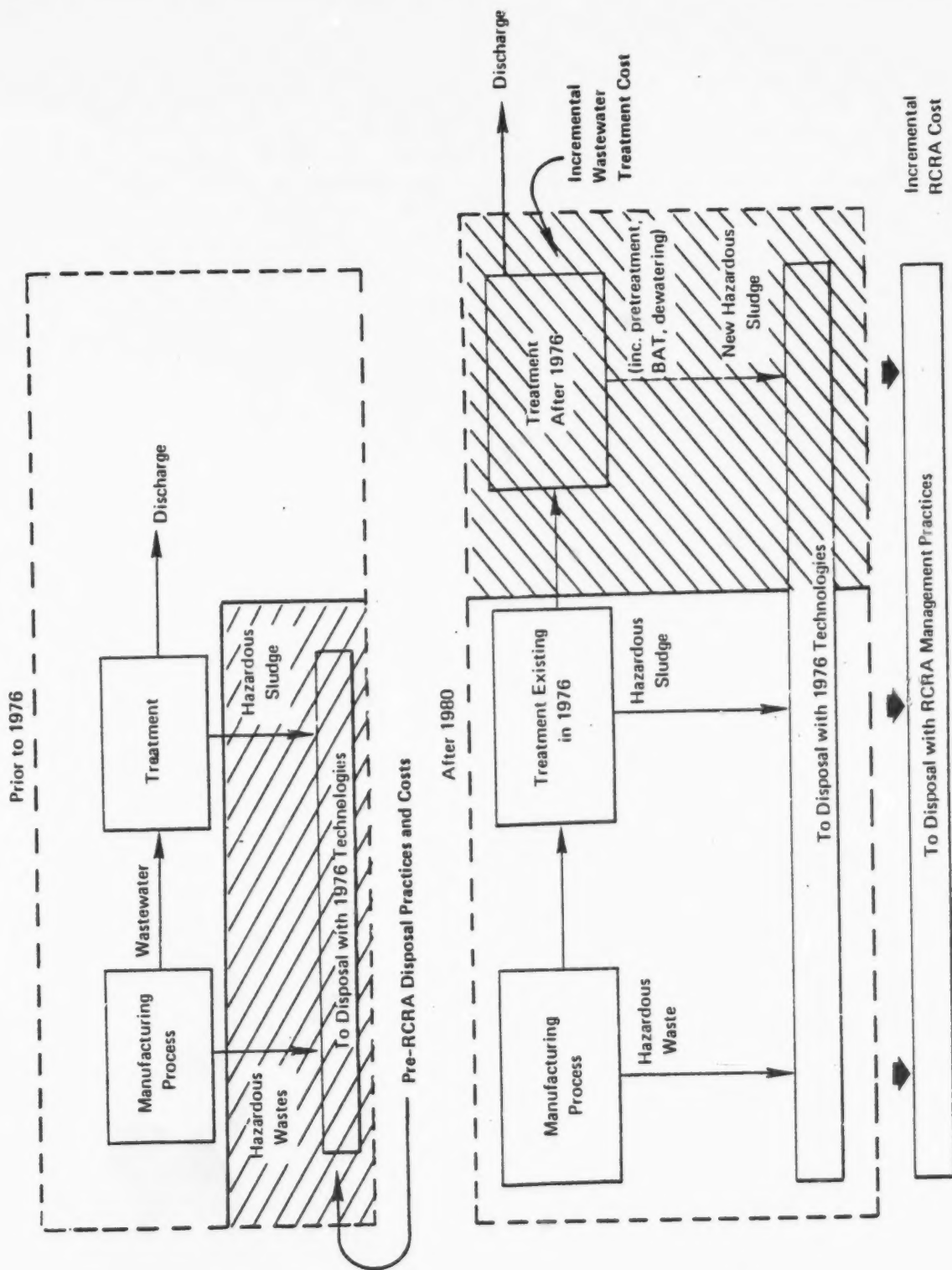
Incineration accounts for only about 2% of total waste disposal. (Many materials that are incinerated are no longer regarded as wastes because of their valuable heat content.) The commercial explosives industry still practices open burning for a small volume of scrap explosive waste where enclosed incineration is not technically feasible. Wastes for ocean disposal (7%) are large-volume wastes from the inorganic chemical industry, which are difficult and expensive to dispose of by any other route. Similarly, wastes being disposed of by deep well injection (19%) are large-volume wastes from segments of the inorganic and organic chemical industries, which are also difficult to manage by any other disposal practice.

The computation of incremental costs requires an estimate of the quantity of wastes managed on site by the generator and the quantity sent to off-site treatment, storage, and disposal facilities. On-site compliance costs are calculated by a different set of formulas from those used for off-site costs. Estimates of the percent of wastes sent off site for treatment and disposal are included in Table IV-23. Twenty percent of the ISS waste is shipped to commercial off-site disposal facilities by the waste generators. Virtually all the waste from eight industries is sent to off-site disposal, while the inorganic chemical and nonferrous industries send less than 10%.

The management of wastewater treatment sludges requires special consideration in this analysis. Figure IV-1 includes a schematic of a typical hazardous waste generating plant in 1976 prior to the enactment of RCRA and the modifications to the plant after 1980 when RCRA regulations are promulgated along with BATEA and pretreatment standards. During the post-1980 period the plant will undertake compliance activities as a result of both RCRA and the Federal Water Pollution Control Act (FWPCA). The FWPCA-induced BATEA and pretreatment regulations will result in new hazardous waste sludges being generated that did not exist in 1976. In EPA's analysis of the FWPCA regulations, estimates are made of the quantity of this new waste and its cost for disposal.

The quantity of new BATEA and pretreatment sludges was estimated for this analysis on an industry-by-industry basis. The 1973-1976 hazardous waste assessment reports included, in some cases, estimates of wastewater treatment sludges after the BATEA and pretreatment standards were implemented. These estimates were revised by, or in consultation with, EPA's effluent guideline contractors and project officers for this analysis. The estimates are subject to further revision because final decisions have not been made on the treatment technologies for many industries.

For the purpose of this analysis, all new wastewater treatment sludges were assumed to be disposed of using the disposal technology for other similar sludges produced by the plant in 1976. This assumption was necessary because a baseline waste disposal practice for the plant had to be established that could be used for all similar wastes. The changes in disposal practices that have taken place since 1976 are generally as a result of impending RCRA regulations and changes in state requirements that are also in anticipation of RCRA. The changes in waste management practices required by RCRA ISS were applied equally during the cost of compliance analysis to waste generated prior to 1976 and waste generated for the first time after 1980 as a result of the effluent guidelines. The year 1978 was taken as the base year for the analysis because it was the last year for which complete production data were available. The waste quantities used in this report assume 1978 production levels, 1976 hazardous waste generation rates from the production/process units, and wastewater treatment sludge generation rates at post-BATEA and pretreatment standard levels.



Source: Arthur D. Little, Inc.

FIGURE IV-1 INCREMENTAL RCRA COMPLIANCE COSTS

D. HAZARDOUS WASTE TRANSPORTATION

Some 1.9 million MT of waste are estimated to be transported off site by barge for ocean disposal. The rest is transported by truck, except for very small amounts removed by rail or pipelines.

E. HAZARDOUS WASTE ASSESSMENT STUDIES

The data on hazardous waste generation and management practices are based on information generated previously for EPA. The reports used are listed below:

1. Battelle Columbus Laboratories. "Assessment of Industrial Hazardous Waste Practices: Electroplating and Metal Finishing Industries — Job Shops," Final Report to U.S. EPA, Office of Solid Waste, Hazardous Waste Management Division, Contract 68-01-2664, September 1976.
2. Calspan Corp. "Assessment of Industrial Hazardous Waste Practices in the Metal Smelting and Refining Industry." U.S. EPA, Office of Solid Waste, Contract 68-01-2604, April 1977.
3. Jacobs Engineering Co. "Assessment of Industrial Hazardous Waste Practices in the Petroleum Refining Industry." Final Report to U.S. EPA, Office of Solid Waste, Contract 68-01-2288, June 1976.
4. Arthur D. Little, Inc. "Hazardous Waste Generation, Treatment, and Disposal in the Pharmaceutical Industry." Report to U.S. EPA, Contract 68-01-2684, 1976.
5. SCS Engineers Inc. "Assessment of Industrial Hazardous Waste Practices: Leather Tanning and Finishing Industry." Report to U.S. EPA, Office of Solid Waste, Hazardous Waste Management Division, Contract 68-01-3261, November 1976.
6. Foster D. Snell, Inc. "Assessment of Industrial Hazardous Waste Practices: Rubber and Plastics Industry" Final Report to U.S. EPA, Office of Solid Waste, Hazardous Waste Management Division, Contract 68-01-3194, March 1978.
7. Swain, John W. Jr. "Assessment of Industrial Hazardous Waste Management Practices: Petroleum Re-refining Industry." U.S. EPA, Office of Solid Waste, September 1978.
8. TRW Systems Group, TRW, Inc. "Assessment of Hazardous Waste Practices: Organic Chemicals, Pesticides, and Explosives Industries." U.S. EPA, Contract 68-01-2919, 1976.

9. Versar, Inc. "Assessment of Industrial Hazardous Waste Practices: Storage and Primary Battery Industries." U.S. EPA, Contract 68-01-2276, 1975.
10. Versar, Inc. "Assessment of Industrial Hazardous Waste Practices, Inorganic Chemicals Industry." Final Report to U.S. EPA, Office of Solid Waste, Contract 68-01-2246, March 1975.
11. Versar, Inc. "Assessment of Industrial Hazardous Waste Practices; Textiles Industry." U.S. EPA, Contract 68-01-3178, June 1976.
12. Wapora, Inc. "Assessment of Industrial Hazardous Waste Practices: Paint and Allied Products Industry." U.S. EPA, Contract 68-01-2656, 1976.
13. Wapora, Inc. "Assessment of Industrial Hazardous Waste Practices: Electronic Components Manufacturing Industry." U.S. EPA, Office of Solid Waste, Hazardous Waste Management Division, Contract 68-01-3193, January 1977.
14. Wapora, Inc. "Assessment of Industrial Hazardous Waste Practices: Special Machinery and Manufacturing." U.S. EPA, Contract 68-01-3193, 1976.

V. METHODOLOGY

A. INTRODUCTION

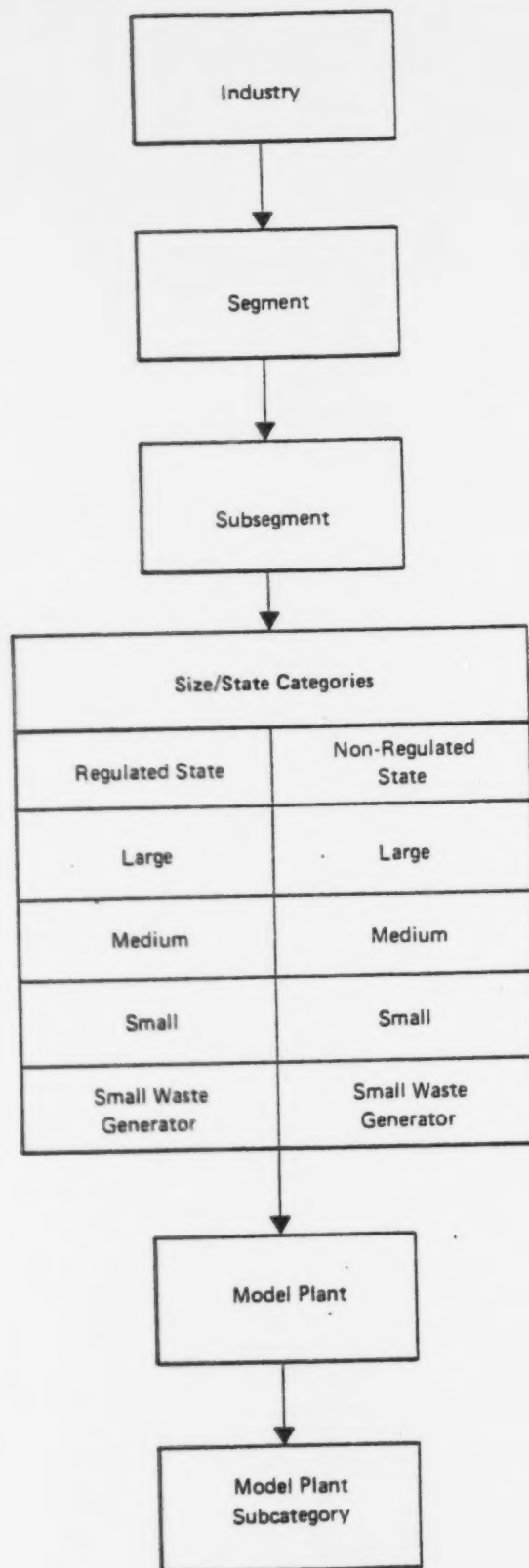
Chapter II outlines the overall approach used to calculate incremental compliance costs and to determine economic impacts for the 22 hazardous waste generating industries studied. This chapter presents details of the methodology used. Three major sections follow, discussing the methodology for developing the model plants, calculating the compliance cost, and determining the economic impacts, respectively.

B. MODEL PLANT DEVELOPMENT METHODOLOGY

Ideally, compliance costs should be estimated plant by plant; specific site conditions vary greatly and can result in large differences in the cost of compliance by plant. Unfortunately, existing data bases are inadequate for such an analysis of the RCRA regulations. Furthermore, the large number of hazardous waste generating plants involved (more than 50,000) makes such analysis unfeasible because of time and budget limitations. As a consequence, this analysis uses model plants to represent classes of actual plants. The models were developed using published data, information from various EPA contractors, and information from Arthur D. Little, Inc., staff familiar with selected industries.

The model plants employed in this study should be reasonably representative of actual practices. A single model plant represents a more or less homogeneous collection of actual plants with respect to size, wastes, manufacturing process, products, etc. because most industries were extensively segmented. The procedure used to define model plants is shown schematically in Figure V-1. The individual steps are:

- Divide a given industry into segments. Segments were chosen to group plants by products, processes, and waste generation and disposal characteristics. Not all industries require segmentation.
- Divide the segments into subsegments. Subsegments were chosen to refine the grouping of plants by product, process, and waste generation and disposal characteristics. Not all segments have subsegments.
- Divide the industry, segment, or subsegment (as appropriate) into a number of size categories and by regulated and non-regulated states. Large, medium, small, and small waste generator size categories were selected because the cost of compliance and the economic impact will vary by plant size. Also, the cost of compliance will vary by plant location because 10 states had regulations with some provisions similar to RCRA as of January 1976. The cost of compliance will be lower for plants in these states.



Source: Arthur D. Little, Inc.

FIGURE V-1 DEFINING A MODEL PLANT

An example of a model plant description at this level of subdivision is a large, non-regulated phenolic resin plant (subsegment) in the plastic materials and resins segment of the plastic materials, synthetic rubbers, and synthetic fibers industry. This particular model plant was used in the sample compliance cost calculation shown in Appendix H.

- Develop the specifications for each model plant. The specifications include:
 - Production rate
 - Number of plants represented
 - Waste stream and waste generation rate
 - Disposal method used and quantity of waste disposed of by each method
 - Number and area of disposal and treatment/storage impoundments.

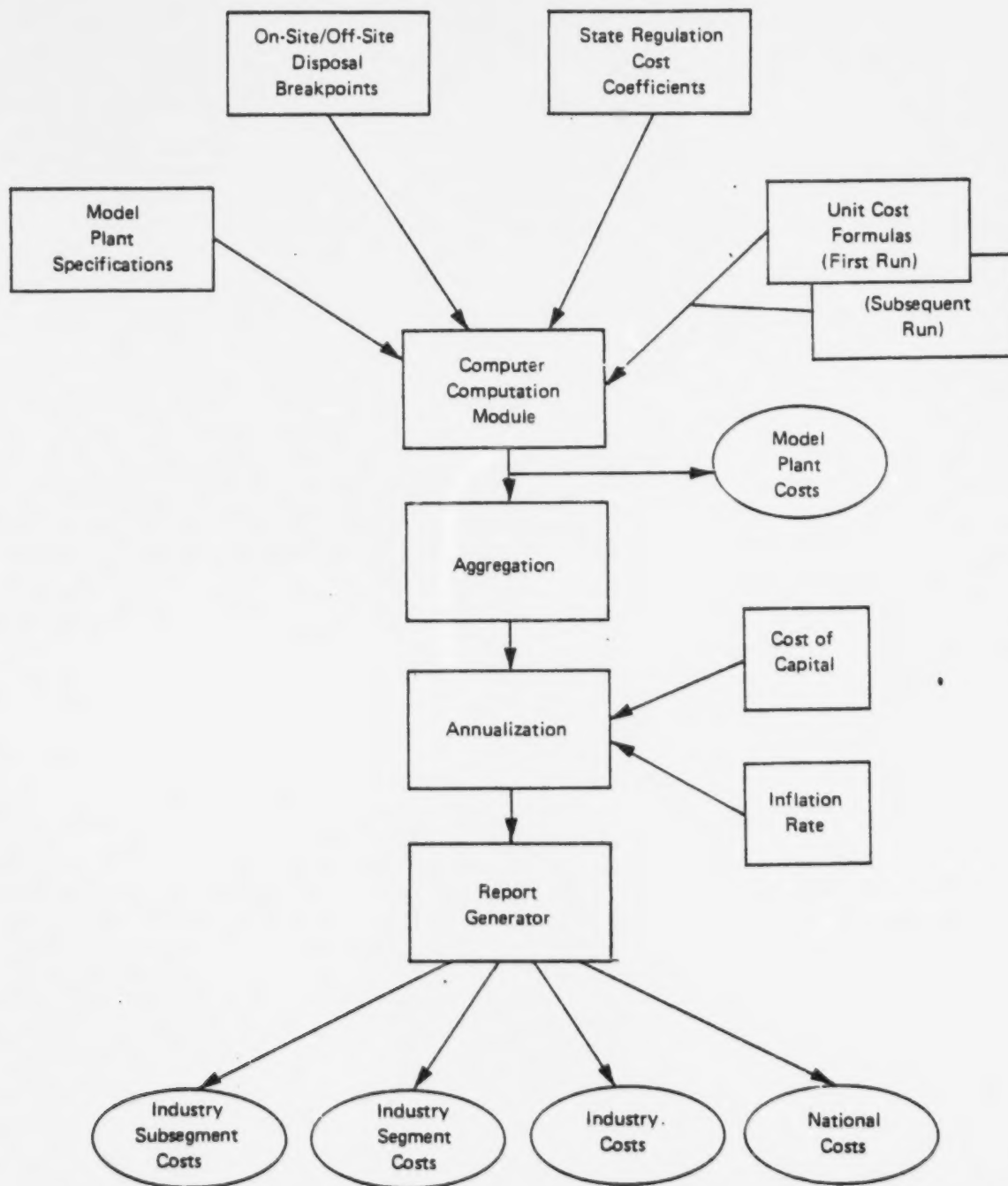
Several sources were used to generate the specifications (see Appendix G for details). They include updated best available technology economically achievable (BATEA) studies, published plant capacity data, Census Bureau data, and miscellaneous sources. Data on surface impoundments were taken largely from the EPA Surface Impoundment Assessment Information System data base. Waste generation rates and disposal practices were obtained from the data given above in Chapter IV.

- Construct model plant subcategories. In some cases it was necessary to construct a model plant subcategory, since not all plants represented by a model generated the same wastes, used the same disposal methods, or had surface impoundments.

Model plants in four of the six "high impact" industries were developed by other contractors. Arthur D. Little, Inc., developed the model plants for two high impact industries (electroplating and nonferrous metals) and for all the other industries. A listing of the sources of data in each industry is given in Appendix G.

C. COMPLIANCE COST COMPUTATION METHODOLOGY

The very complex model plant cost calculation and aggregation procedure was performed on a computer. Appendix I presents the computer program. Figure V-2 shows the general procedural flow.



Source: Arthur D. Little, Inc.

FIGURE V-2 COMPLIANCE COST PROCEDURE

1. Inputs

The major inputs to the computer program are:

- Model plant specifications
- Unit cost formulas
- State regulation cost coefficients
- On-site/off-site volume breakpoints

a. Model Plants

The derivation of model plants is discussed in Section B above. The model plant data used in the analysis appear in Appendix G.

b. Unit Costs

Compliance costs were computed by applying a unit cost formula for each separate compliance activity to the specifications of each model plant. The compliance cost categories used in organizing the formulas are:

- On-site treatment/disposal
- Off-site treatment/disposal
- Recordkeeping and reporting
- Monitoring and testing
- Administration
- Training
- Contingency plan
- Closure fund

Table V-1 gives the complete set of formulas employed. Table V-2 shows the nomenclature used in the formulas. The derivation of the formulas is given in Appendix B. Each formula is based on an estimate of the activity level required to comply with a part of the RCRA regulations. (See Table V-1 for the specific Part of the regulations and RCRA Section reference.) Compliance costs occur in several temporal patterns and accounting categories as follows:

- *Capital costs.* One-time costs for facilities or facility improvements that will be incurred within the first year after promulgation of the ISS. Generators will generally depreciate these costs rather than expense them. Fencing and runoff control systems are examples of capital costs.
- *Initial costs.* One-time costs that the generator will incur within the first year after the promulgation of the ISS. These costs will generally be expensed (treated as one-time operating costs). Initial training and purchase of safety equipment are examples of initial costs.

TABLE V-1

ISS COMPLIANCE COSTING FORMULAS - FIRST RUN COSTS

TREATMENT/DISPOSAL REQUIREMENTS

Formula Applicability	Formula Number	Formula	Cost Type	RCRA Section	Comments
On-site land treatment specific cost	TR-1	$(3,100 + 27 \sqrt{60M}) N_{ON}$	Capital	3004-\$265.272	Land treatment runoff control
On-site landfill specific cost	TR-2	$(3,100 + 27 \sqrt{127M^{(0.651)}}) N_{ON}$	Annual	3004-\$265.272	Landfill runoff control
On-site landfill specific cost	TR-3	$(87(M)^{0.575} + 141.5(M)^{0.597}) N_{ON}$	Annual	3004-\$265.314	Annual closure of a cell
Off-site sanitary landfill specific cost	TR-4	$7.45 MN_{OFF}$	Annual	3004-\$265.314	Landfill treatment/disposal cost
Off-site incinerator (halogenated) specific cost	TR-5	$18.32 MN_{OFF}$	Annual	3004-\$265.343	Treatment/disposal cost associated with incinerators equipped with scrubbers
Off-site incinerator (hydrocarbon) specific cost	TR-6	$5.74 MN_{OFF}$	Annual	3004-\$265.343	Treatment/disposal cost associated with incinerators not equipped with scrubbers
Off-site secure landfill specific cost	TR-7	$9.33 MN_{OFF}$	Annual	3004-\$265.343	Off-site treatment/disposal cost
Off-site secure drummed waste specific cost	TR-8	$9.33 MN_{OFF}$	Annual	3004-\$265.343	Off-site treatment/disposal cost
Off-site dump specific cost	TR-9	$6.74 MN_{OFF}$	Annual	3004-\$265.343	Off-site disposal cost
Off-site land treatment specific cost	TR-10	$8.79 MN_{OFF}$	Annual	3004-\$265.343	Off-site disposal cost
Off-site specific cost for generators with average off-site wastes (M/N_W) ≤ 80 tons	TR-11	$600 N_{OFF} N_W (1.2985)$	Annual	3004-\$264.13	Sampling and analysis of wastes transported off site
Off-site specific cost for generators with average off-site wastes 80 tons $< (M/N_W) \leq 160$ tons	TR-12	$N_{OFF} N_W A_W (800/160 + 50/20) (1.2985)$	Annual	3004-\$264.13	Sampling and analysis of wastes transported off site
Off-site specific costs for generators with average off-site wastes (M/N_W) > 160 tons	TR-13	$N_{OFF} N_W [A_W (50/20) + 800] (1.2985)$	Annual	3004-\$264.13	Sampling and analysis of wastes transported off site

TABLE V-1 (Continued)

ISS COMPLIANCE COSTING FORMULAS - FIRST RUN COSTS

RECORDKEEPING AND REPORTING REQUIREMENTS

Formula Applicability	Formula Number	Formula	Cost Type	RCRA Section	Comments
Cost to all generators	RR-1	$N_G (1/2 \text{ Cler} + \text{Tech}_G)$	Initial	3002 - §262.12	Initial cost of ID code/notification
Off-site specific cost	RR-2	$0.05 N_M (1/2 \text{ Cler} + 1/2 \text{ Tech}_G)$	Annual	3002 - §262.42	Exception reporting
Cost to all generators	RR-3	$N_G (2 \text{ Tech}_G + \text{Cler})$	Annual	3002 - §262.41	Annual reports
Off-site specific cost	RR-4	$110 N_{OFF}$	Annual	3002 - §262.40	Recordkeeping, ongoing review and filing
Off-site specific cost	RR-5	$N_{OFF} (20 + 5 \text{ Tech}_G + 5 \text{ Supv})$	Annual	3002 - §262.23	Manifest storage and filing
On-site specific cost	RR-6	$N_{ON} (20 + 12 \text{ Cler})$	Annual	3004 - §264.16	Training recordkeeping
On-site specific cost	RR-7	$N_{ON} (\text{Cler} + \text{Tech}_G)$	Annual	3004 - §264.75	Annual reporting
On-site specific cost	RR-8	$N_{ON} (24 \text{ Tech}_G + 72 \text{ Cler} + 20)$	Annual	3004 - §264.73	Disposal records
On-site specific cost (non-incinerator)	RR-9	$N_{ON} (8 \text{ Tech}_G + 3 \text{ Cler} + 20)$	Annual	3004 - §265.94	Non-incinerator groundwater monitoring
On-site specific cost (incinerator only)	RR-10	$2 N_{ON} (8 \text{ Tech}_G + 2 \text{ Supv} + 3 \text{ Cler} + 20)$	Annual	3004 - §265.94	Incinerator groundwater monitoring
On-site specific cost	RR-11	$N_{ON} (\text{Tech}_G + 1/2 \text{ Cler})$	Initial	3005 - §122.24 3005 - §122.25	Initial cost of ID code application/notification
On-site specific cost	RR-12	$N_{ON} (20 \text{ Supv} + 40 \text{ Tech}_G + 15 \text{ Cler})$	Initial	3005 - Subpart A	Preparation of Part A of permit

TABLE V-1 (Continued)

ISS COMPLIANCE COSTING FORMULAS - FIRST RUN COSTS
MONITORING AND TESTING REQUIREMENTS

Formula Applicability	Formula Number	Formula	Monitoring and Testing Code	Cost	Cost Type	RCRA Section	Comments
Waste stream specific cost	MT-1		A B C NA	45N _W N _G 600N _W N _G 400N _W N _G 400N _W N _G	Initial	3001-Subparts B & C	Initial cost of applying hazardous waste criteria
Waste stream specific cost	MT-1a		3,014 N _G N _W		Initial	3004-§ 265.13	Sampling development
On-site, disposal mode-specific cost (non-incinerator only)	MT-2		23,000 N _{ON}		Capital	3004-§ 265.91	Monitoring wells
On-site, disposal mode-specific cost (secure and sanitary landfill, impoundment, dump, and drummed wastes only)	MT-3		3,080 N _{ON}		Initial	3004-§ 265.91	Monitoring
On-site disposal mode-specific cost (secure or sanitary landfill, impoundment, dump, or drummed waste disposal only)	MT-4		3,400 N _{ON}		Annual	3004-§ 265.13	Annual on-site waste analysis cost for landfills and disposal impoundments
On-site disposal mode-specific cost (incinerators only)	MT-5		11,000 N _{ON}		Annual	3004-§ 265.13	Annual on-site waste analysis cost for incinerators
On-site, disposal mode-specific cost (secure and sanitary landfill, impoundment, dump, and drummed wastes only)	MT-6		1,220 N _{ON}		Annual	3004-§ 265.91	Monitoring
On-site land treatment specific cost	MT-6a		3,300 N _{ON}		Initial	3004-§ 265.278	Initial testing
On-site, land treatment specific cost	MT-7		39,900 N _{ON}		Annual	3004-§ 265.278	Unsaturated zone monitoring

TABLE V-1 (Continued)
ISS COMPLIANCE COSTING FORMULAS - FIRST RUN COSTS
ADMINISTRATIVE REQUIREMENTS

Formula Applicability	Formula Number	Formula	Cost Type	RCRA Section	Comments
Off-site, disposal mode/ waste stream specific cost	AD-1	$3N_{OFF}N_W(\text{Cler} + \text{Tech}_G)$	Initial	3001-Subparts A, B, C, D	Initial cost of documenting inventory
Waste stream/disposal mode specific cost	AD-2	$2N_GN_W(\text{Cler} + \text{Tech}_G)$	Initial	3001-Subparts A, B, C, D	Initial cost of applying hazardous waste list
Waste stream/disposal mode specific cost	AD-3	$2.2N_GN_W\text{Supv}$	Initial	3001-Subparts A, B, C, D	Initial cost of incremental supervision
Cost to all generators	AD-4	$N_G(\text{Cler} + \text{Tech}_G)$	Annual	3001-Subparts A, B, C, D	Annual re-evaluation of hazardous waste list
Off-site specific cost	AD-5	$N_{OFF}(16\text{ Cler} + 19\text{ Tech}_G)$	Initial	3002-§§262.11, 262.12	Initial cost of designing and implementing compliance procedures
Site-specific cost	AD-6	$12N_{OFF}\text{Supv}$	Initial	3002-§262.11	Initial cost of supervision
Manifest specific cost	AD-7	$1/3N_M\text{Cler}$	Annual	3002-§§262.20, 262.21, 262.22, 262.23	Annual cost of preparing manifest
Off-site specific cost	AD-8	$24N_{OFF}\text{Supv}$	Annual	3002-§§262.30, 262.31, 262.32, 262.33, 262.34	Annual cost of ongoing supervision
Disposal mode/manifest specific cost	AD-9	$3/4N_M\text{Truck}[(1/2 + (15/60)(0.15))]$	Annual	3003-§263.20	Transportation
Disposal mode/manifest specific cost	AD-10	$1/4N_M\text{Truck}[(1/6 + (15/60)(0.15))]$	Annual	3003-§263.20	Transportation
On-site specific cost	AD-11	$N_{ON}(40\text{ Tech}_G + 30\text{ Cler})$	Initial	3004-§265.142	Financial requirement plan design
On-site specific cost	AD-12	$N_{ON}(90\text{ Tech}_G + 32\text{ Cler})$	Initial	3004-§264.13	Waste plan
On-site specific cost	AD-13	$N_{ON}(35\text{ Tech}_G + 15\text{ Cler})$	Initial	3004-§265.70	Recordkeeping, logging, incidents
On-site specific cost	AD-14	$15N_{ON}\text{Supv}$	Initial	3004-§265.70	General overhead
Off-site specific cost	AD-15	$100N_{OFF}$	Initial	3004-§264.15	Inspection plan
Off-site specific cost	AD-16	$1500N_{OFF}$	Annual	3004-§264.15	Inspection
On-site, disposal mode specific cost	AD-17	$25N_{ON}\text{Tech}_G$	Annual	3004-§264.15	Weekly inspections
On-site, disposal mode specific cost	AD-18	$N_{ON}(40\text{ Supv} + 20\text{ Tech}_G + 15\text{ Cler})$	Initial	3005-§122.24	Preparation of permit application

TABLE V-1 (Continued)

ISS COMPLIANCE COSTING FORMULAS - FIRST RUN COSTS

TRAINING REQUIREMENTS

Formula Applicability	Formula Number	Formula	Cost Type	RCRA Section	Comments
On-site specific cost	TG-1	10,175 N _{ON}	Initial	3004-§264.16	Development of training program
On-site specific cost for landfills and Incinerators with ≤ 20,000 MT/yr waste or impoundments and land treatment with ≤ 2.15 acres	TG-2	3,000 N _{ON}	Annual	3004-§264.16	On-the-job or classroom training of 10 employees
On-site specific costs for landfills and Incinerators with > 20,000 MT/yr waste or land treatment and impoundments with > 2.15 acres	TG-3	4,500 N _{ON}	Annual	3004-§264.16	On-the-job or classroom training of 15 employees

TABLE V-1 (Continued)

ISS COMPLIANCE COSTING FORMULAS - FIRST RUN COSTS

CONTINGENCY PLAN REQUIREMENTS

Formula Applicability	Formula Number	Formula	Cost Type	RCRA Section	Comments										
On-site specific cost	CP-1	$10,000 N_{ON}$	Capital	3004-§264.51	Contingency plan										
On-site land treatment specific cost	CP-2	$\left((325 + 48 \sqrt{60 M}) N_{ON} \right)$	Capital	3004-§264.51	Fencing										
On-site impoundment specific cost	CP-3	$\left((325 + 48 \sqrt{43,560 \times 1.37 (A)^{0.4}}) N_{ON} N_I^{(0.5)} \right)$	Capital	3004-§265.51	Fencing										
Off-site specific cost	CP-4	<table><tr><th>M</th><th>Cont</th></tr><tr><td>0- 2,000</td><td>1,038</td></tr><tr><td>2,001- 5,500</td><td>1,786</td></tr><tr><td>5,501-20,000</td><td>2,309</td></tr><tr><td>> 20,000</td><td>3,559</td></tr></table> $2 N_{OFF} \text{ Cont}$	M	Cont	0- 2,000	1,038	2,001- 5,500	1,786	5,501-20,000	2,309	> 20,000	3,559	Capital	3004-§265.192	Tank containment
M	Cont														
0- 2,000	1,038														
2,001- 5,500	1,786														
5,501-20,000	2,309														
> 20,000	3,559														
Off-site specific cost	CP-5	$66 N_{OFF}$	Initial	3004-§265.194	Security										
On-site landfill specific cost	CP-6	$\left((325 + 48 \sqrt{127 (M)^{0.451}}) N_{ON} \right)$	Annual	3004-§264.51	Fencing										
On-site specific cost	CP-7	$N_{ON} (30 \text{ Supv} + 15 \text{ Tech}_G + 10 \text{ Cler})$	Initial	3005-§122.24	Description of security procedures										

TABLE V-1 (Continued)

ISS COMPLIANCE COSTING FORMULAS - FIRST RUN COSTS
CLOSURE FUND REQUIREMENTS

Formula Applicability	Formula Number	Formula	Cost Type	RCRA Section	Comments
On-site specific cost; off-site tanks - specific cost	CF-1	500 N _{ON} 500 N _{OFF}	Closure fund	3004-§265.111, 265.112, §265.113, 265.117 §265.118	Administrative overhead
On-site sanitary or secure landfill, dump or drummed waste specific cost	CF-2	M Range 0- 1,000 1,001- 2,000 2,001- 5,500 5,501-20,000 > 20,000	Closure fund	3004-§265.310	Closure costs
On-site secure or sanitary landfill, dump or drummed waste specific cost	CF-3	M Range 0- 1,000 1,001- 2,000 2,001- 5,500 5,501-20,000 > 20,000	Closure fund	3004-§265.310	Post-closure costs
Off-site specific cost	CF-4	(2 Tank + 100) N _{OFF} M Tank 0-2,000 2,001-5,500 5,501-20,000 > 20,000	Closure fund	3004-§265.197	Tank
On-site land treatment specific cost	CF-5	Closure costs = 4,245 N _{ON} Post closure costs = 0	Closure fund	3004-§265.280	Post-closure and closure costs

TABLE V-1 (Continued)

ISS COMPLIANCE COSTING FORMULAS - FIRST RUN COSTS
CLOSURE FUND REQUIREMENTS

Formula Applicability	Formula Number	Formula	Cost Type	RCRA Section	Comments
On-site incinerator (halogenated) specific cost	CF-6	$\begin{array}{l} \text{M Range} \\ 0-1,000 \\ 1,001-5,000 \\ 5,001-10,000 \\ 10,001-20,000 \\ >20,000 \end{array}$ $\begin{array}{l} \text{Total Closure Costs} \\ 223,000 N_{ON} \\ 290,000 N_{ON} \\ 338,000 N_{ON} \\ 311,000 N_{ON} \\ 320,000 N_{ON} \end{array}$	Closure fund	3004-§265.351	Total closure costs for incinerators equipped with scrubbers
On-site incinerator (hydrocarbon) specific cost	CF-7	$\begin{array}{l} \text{M Range} \\ 0-1,000 \\ 1,001-5,000 \\ 5,001-10,000 \\ 10,001-20,000 \\ >20,000 \end{array}$ $\begin{array}{l} \text{Total Closure Costs} \\ 196,000 N_{ON} \\ 202,000 N_{ON} \\ 204,000 N_{ON} \\ 194,000 N_{ON} \\ 195,000 N_{ON} \end{array}$	Closure fund	3004-§265.351	Total closure costs for incinerators not equipped with scrubbers
On-site incinerator specific cost	CF-8	$\begin{array}{l} \text{M Range} \\ 0-1,000 \\ 1,001-5,000 \\ 5,001-10,000 \\ 10,001-20,000 \\ >20,000 \end{array}$ $\begin{array}{l} \text{Closure Costs} \\ 1,600 N_{ON} \\ 1,620 N_{ON} \\ 2,750 N_{ON} \\ 3,780 N_{ON} \\ 6,750 N_{ON} \end{array}$	Closure fund	3004-§265.351	Total incinerator post-closure costs
On-site disposal and treatment/storage impoundment specific cost	CF-9	$\begin{array}{l} \text{Impoundment Size (acre)} \\ 0-1 \\ 1-2.15 \\ >2.15 \end{array}$ $\begin{array}{l} \text{Closure Costs} \\ 2,175 N_I \\ 2,405 N_I \\ 2,750 N_I \end{array}$	Closure fund	3004-§265.238	Impoundment closure costs
On-site disposal impoundment specific cost	CF-10	$\begin{array}{l} \text{Impoundment Size (acre)} \\ 0-1 \\ 1-2.15 \\ >2.15 \end{array}$ $\begin{array}{l} \text{Post-Closure Costs} \\ 115,500 N_I \\ 124,500 N_I \\ 131,100 N_I \end{array}$	Closure fund	3004-§265.238	Post-closure costs
On-site landfill specific cost	CF-11	$87 (M)^{0.575} + 141.5 (M)^{0.597} N_{ON}$	Closure fund	3004-§265.310	Landfill size-dependent closure cost
On-site land treatment specific cost	CF-12	$10.375 N_{ON}$	Closure fund	3004-§265.280	Land treatment size-dependent closure cost
On-site impoundment specific cost	CF-13	$N_I (45,360 (A)^{0.982} + 25,250 (A)^{0.947}) N_{ON}$	Closure fund	3004-§265.278	Impoundment size-dependent closure cost

Sources: Arthur D. Little, Inc., estimates.

TABLE V-2

COMPLIANCE COST FORMULA NOMENCLATURE

A	Surface impoundment area (acres)
A_W	Average quantity of hazardous waste sent off site per waste stream by a generator (MT/yr) = M/N_W
Cler	Unit wage rate for a clerical worker (\$9.00/hr)
Cont	Cost of installing tank containment (\$)
M	Total hazardous waste generated annually by a model plant (MT/yr)
N_C	Number of different monitoring and testing codes for a model plant
N_G	Number of generators represented by a model plant
N_I	Number of impoundments
N_M	Number of manifests prepared by a model plant
N_{OFF}	Number of generators that dispose of hazardous wastes in off-site facilities
N_{ON}	Number of generators that dispose of hazardous wastes in on-site facilities
N_T	Number of transporters
N_W	Number of hazardous waste streams produced by a model plant
P	Percent of plants at Level 1
Supv	Unit wage rate for a supervisory engineer or research executive (\$27.50/hr)
Tank	Cost of decontaminating and decommissioning hazardous waste storage tank (\$)
Tech _G	Unit wage rate for an engineer employed by a hazardous waste generator (\$29.00/hr)
Tech _{TSDf}	Unit wage rate for an engineer employed by a TSDf (\$35.00/hr)
Truck	Unit wage rate for a truck driver (\$13.50/hr)

Source: Arthur D. Little, Inc.

- *Annual costs.* Costs that will be incurred each year over the life of the regulations. Recordkeeping, monitoring, and annual landfill closure are examples.
- *Closure and post-closure fund costs.* The analysis used a combined closure/post-closure trust fund. Of the several alternatives that would satisfy the financial assurance requirements of the regulations, the combined fund offered the advantage of simplicity. In this approach, expenditures for surface impoundment, land treatment, and incinerator closure will occur only once, at the time of facility closure. One-twentieth of the total cost plus a correction for inflation must be made during each of the first 20 years of facility operation to cover the cost of closure. This analysis treats these payments as closure fund costs. Such post-closure costs as monitoring are also included in determining the fund requirements. The closure fund costs are very sensitive to the financial assumptions. The analysis assumed, conservatively, that the fund would be invested in government bonds and would appreciate at exactly the inflation rate. A higher rate of appreciation would reduce the annual contributions to the trust. On the other hand, the analysis did not include any provision for income taxes on the trust earnings, and therefore understates the annual contributions required. The closure fund results reported in Chapter VI include a portion attributable to the actual operating costs for closure and post-closure and a portion attributable to the imposition of financial requirements to ensure the availability of funds. Use of a mechanism other than the trust fund, e.g., a simple means test, would significantly reduce that portion of the overall compliance costs incurred to meet the financial requirements.

Off-site (treatment/disposal) unit costs are the fees charged by commercial disposal firms for waste disposal "off-site" from the generator's plant (see Appendix C for details). Incremental disposal prices include the operational compliance activities (except testing) as described in Table V-1, plus overhead and capital charges. Testing charges are added to the other operational costs and are, for all but the very large generators, the predominant factor in the overall incremental cost. The incremental prices charged by commercial disposal firms as a result of the ISS become an incremental cost of compliance for waste generators.

c. State Regulation

Incremental RCRA compliance costs, as noted earlier, are expenditures made by hazardous waste generating plants as a result of compliance with ISS RCRA over and above any other Federal or state waste management requirements. Regulations in 10 states preceded the RCRA regulations and, as a result, plants in these states already utilized some ISS practices prior to the promulgation of RCRA regulations. The RCRA formula costs for plants in these states were produced by applying the fractional coefficients given in Table V-3. These coefficients, developed by Arthur D. Little, Inc., personnel in consultation with EPA staff, represent the fraction of total

TABLE V-3
STATE REGULATION COST COEFFICIENTS

Activity	Regulation Section				
	3001	3002	3003	3004	3005
Treatment/ Disposal	— ^a	—	—	0.75	—
Recordkeeping and Reporting	—	0.44	—	0.75	0.85
Monitoring and Testing	0.35	—	—	0.75	—
Administrative	0.35	0.44	0.3	0.75	0.85
Training	—	—	—	0.75	—
Contingency Plan	—	—	—	0.75	0.85
Closure Fund	—	—	—	1.0	—

a. Denotes coefficient not applicable to the regulations covered in this analysis.

Source: Arthur D. Little, Inc.

compliance costs that remains after the higher level of current state regulations are taken into account. Coefficients are broken down by type of activity and RCRA section.

In regulated states, for example, only 30% of the administrative costs resulting from implementation of Section 3003 are added into the RCRA incremental cost. The total excludes the other 70%. For closure requirements, however, all costs (100%) are counted as RCRA incremental costs, since none of the states incorporated this feature in its regulations.

d. On-site/Off-site Breakpoint

Generators of hazardous wastes choose between on-site or off-site treatment and disposal for a variety of reasons. In the majority of cases, data on actual practices were not available, and the distribution of waste on and off site was assigned by a minimum costs to the generator rule. The least-cost alternative was assumed to be simply a function of the volume of waste generated. For volumes larger than a specified breakpoint, firms would use on-site waste disposal practices, thereby obtaining economies of scale. Firms with volumes lower than the breakpoints were assumed to employ off-site disposal with fees lower than the cost of on-site disposal at the scale of a plant's generation rate. The breakpoints used are given in Table V-4.

TABLE V-4
ON-SITE/OFF-SITE DECISION BREAKPOINTS

Treatment/Disposal Technique	Volume Below Which Waste is Sent Off-Site
	(MT/yr)
Recycle ^a	0
Sanitary Landfill	5,000
Land Treatment	1,000
Incinerator With Scrubber	6,000
Incinerator Without Scrubber	4,000
Monofill ^a	1,000
Surface Impoundment	0
Secure Landfill	10,000
Dump	1,000
Drummed Landfill	10,000

a. Not used in this analysis.

Source: Arthur D. Little, Inc.

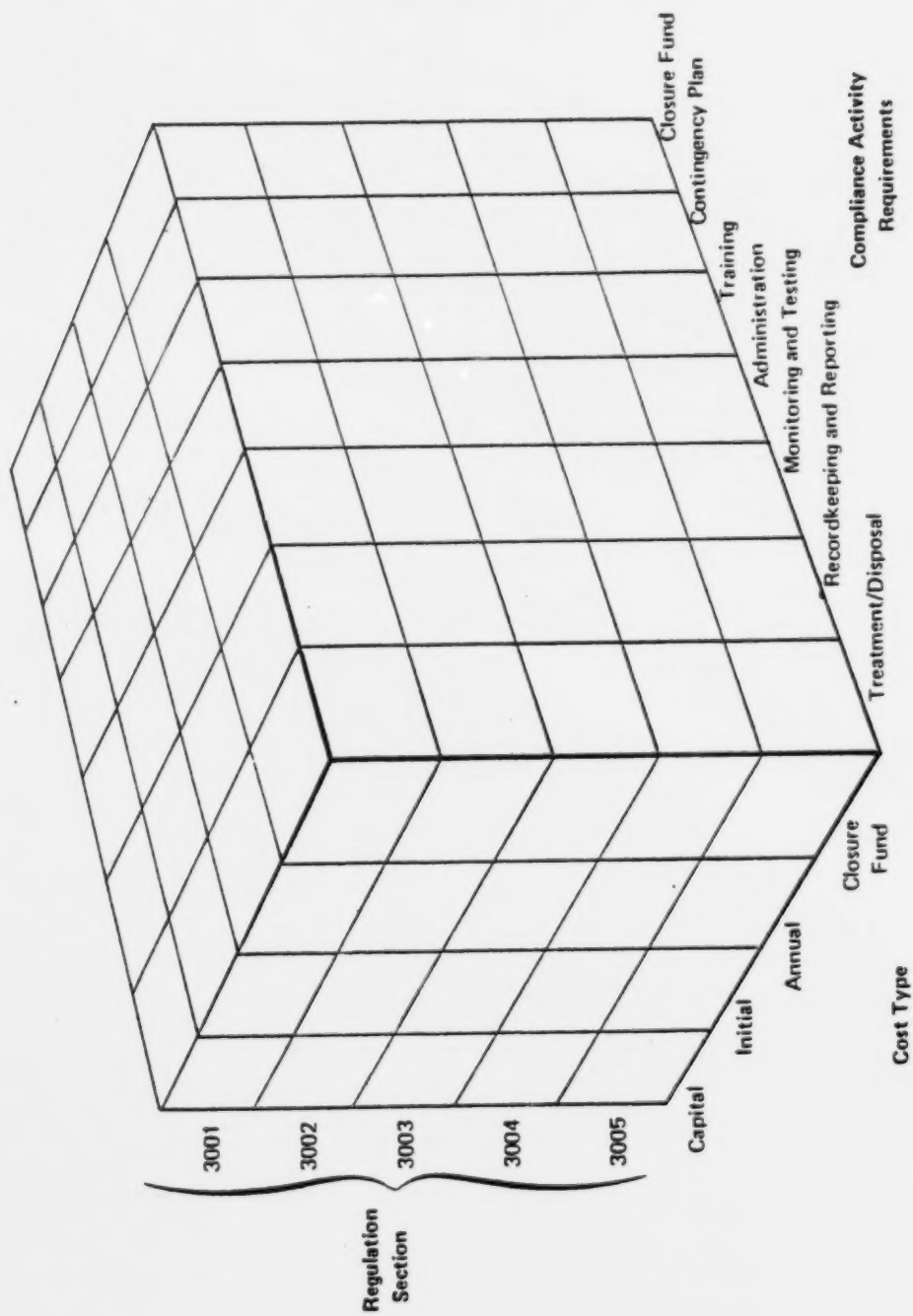
The generic volume decision rule was overridden in two of the industries where detailed information was available. For leather tanning and finishing and for some product categories in the organic chemical industry, the off-site/on-site division was specified for the model plants using the actual industry data.

2. Calculation and Aggregation Procedure

The unit costs are segregated according to cost type (capital, initial, annual, and closure fund); compliance activity (treatment/disposal including off-site transportation/disposal, recordkeeping and reporting, monitoring and testing, administration, training, contingency plan, and closure fund); and relevant section of the regulation (3001, 3002, 3003, 3004, and 3005). Figure V-3 presents these costs in a three-dimensional array. These categories are used for aggregating the total costs.

In order to facilitate the cost calculation, the costs were further subdivided into the following categories:

- a. Plant-specific costs — costs incurred by all plants generating more than 12 metric tons (MT)/year of hazardous waste, independent of whether waste disposal is on site or off site, the number of waste streams, the disposal method, and the total amount of waste generated.
- b. Waste stream-specific costs — costs that are a function of the number of waste streams and their physical/chemical/biological properties, independent of quantity of hazardous waste in the stream or the disposal method.



Sources: Arthur D. Little, Inc.

FIGURE V-3 VISUAL REPRESENTATION OF CATEGORIES OF COMPLIANCE COSTS

- c. On-site-specific costs — costs incurred by a generator solely because disposal is on site, independent of quantity of waste or disposal method.
- d. Off-site-specific costs — costs incurred by a generator solely because disposal is off site, independent of quantity of waste or disposal method.
- e. On-site disposal method-specific costs — costs related only to a given on-site disposal method; sometimes dependent on the waste quantity directed to the disposal method or dependent on the number and area of surface impoundments or landfill sites.
- f. Off-site disposal method-specific costs — costs related only to a given off-site disposal method.

In calculating compliance costs, one run is made for each model plant for each disposal technology used by that model plant. In order to make the results invariant relative to the order in which the several technologies appear in the report data, two sets of cost formulas were developed. The first set, called first-run costs (shown above as Table V-1) includes all of the general non-technology-specific costs (categories a through d above) and the costs specifically associated with the first chosen disposal method. The second set, called subsequent-run costs (included in Appendix I), includes only disposal method-specific costs (categories e and f above).

For example, compliance costs for a model plant using three disposal technologies are calculated as follows:

- Choose one disposal method — compute the costs using the first-run set of cost formulas. The resulting costs include not only the costs of disposal, but the nondisposal technology-specific costs as well.
- Choose a second disposal method — compute costs using the subsequent-run set of cost formulas, which include only the costs of disposal.
- Choose the last disposal method — again compute costs using the subsequent-run set of cost formulas.
- Add cost terms together by type, e.g., capital, annual, etc., to get the total plant compliance costs. These costs are then aggregated in various ways to give model plant costs and total industry costs.

Sample calculations using this procedure appear in Appendix H. Two sets of calculations are given. The first, for the phenolic industry segment, is representative of the industries for which Arthur D. Little, Inc., developed the model plants and performed the economic impact analyses. The second, for the small plant size of the nonchrome tanning subsegment of the leather tanning and finishing industry,

is representative of the six "high impact" industries for which specific contractors developed the model plants and performed the economic impact analyses. Arthur D. Little, Inc., computed the compliance costs for all 22 industries.

3. Annualization

The four different types of costs (see Table II-2) cannot simply be added together, since they are incurred at different times. To provide a basis for making simplified comparisons, and for the qualitative impact analyses, a single number, the annualized incremental cost, is obtained by: 1) projecting all costs over a 20-year assumed plant life taking inflation into account; 2) calculating the present value of this uneven series of expenditures; and 3) converting the present value to an annuity with 20 equal yearly payments. The annualized cost calculated in this way is a nominal value representing an equal annual payment a company would make for RCRA costs each year for twenty years. Thus, the present value of those payments equals the present value of the actual cost over the same period.

The annualized cost can be used for comparison with the level of business activities over the long run. For short-run impacts, the initial cash requirements in the first few years may be more important than the annualized cost. Both figures are presented in the following chapter giving the results.

The formulas used to convert incremental costs to an annualized cost are given in Table V-5, assuming use of a combined closure/post-closure trust fund. The formulas appear more complicated than those found in conventional annuity or present-value tables because the inflation rate and capital factor (discount rate) are assumed to change after the first five years. The second term in the large square brackets in Table V-5 represents the summation of these factors for years 6 through 20.

For other financial assurance mechanisms, the annualization treatment would be different. Actual closure and post-closure costs (as contrasted to fund payments) are operating costs independent of the fund mechanism. The annualized closure costs would be treated as a future capital cost, based on the unit closure cost in 1978 dollars, inflated over a 20-year period, and discounted over the same period to convert to present net value. The computations of annualized post-closure costs would treat these costs in the same manner as annual costs, except that the time period would run from 20 to 50 years.

Financial assurance costs, such as insurance or bond premiums, costs of letters of credit, and fund management fees, would be annual costs.

Trust funds require special treatment to separate the actual closure and post-closure costs from the costs of managing the financial mechanism. In the simplified combined treatments used in this analysis, the present value of the financial management portion is obtained by subtracting the present values of the actual closure and post-closure costs from the present value of the combined fund.

TABLE V-5

FORMULAS FOR ANNUALIZING COSTS

Capital or Initial Cost

$$\text{Annualized Cost} = (\text{Initial or Capital Cost}) \left[\frac{1 + \frac{\text{Inf}_1}{2}}{1 + \frac{\text{CF}_1}{2}} \right] (\text{Annuity factor})$$

$$= 0.1743 (\text{Initial or Capital Cost})$$

Annual

$$\text{Annualized Cost} = \text{Annual Cost} \left[\sum_{n=1}^5 \left(\frac{1 + \text{Inf}_1}{1 + \text{CF}_1} \right)^n + \left(\frac{1 + \text{Inf}_1}{1 + \text{CF}_1} \right)^5 \sum_{n=1}^{15} \left(\frac{1 + \text{Inf}_2}{1 + \text{CF}_2} \right)^n \right] (\text{Annuity factor})$$

$$= 1.791 (\text{Annual Cost})$$

Closure Fund

$$\text{Annualized Cost} = \frac{\text{Closure Fund}}{y} \left[\sum_{n=1}^5 \left(\frac{1 + \text{Inf}_1}{1 + \text{CF}_1} \right)^n + \left(\frac{1 + \text{Inf}_1}{1 + \text{CF}_1} \right)^5 \sum_{n=1}^{15} \left(\frac{1 + \text{Inf}_2}{1 + \text{CF}_2} \right)^n \right] (\text{Annuity factor})$$

y = years over which fund is built up

For y = 20 yrs

$$\text{Annualized Cost} = 1.791 \left(\frac{\text{Closure Fund}}{20} \right)$$

Annuity Factor

$$\text{Annuity Factor} = \left[\sum_{n=1}^5 \left(\frac{1}{1 + \text{CF}_1} \right)^n + \left(\frac{1}{1 + \text{CF}_1} \right)^5 \sum_{n=1}^{15} \left(\frac{1}{1 + \text{CF}_2} \right)^n \right]^{-1} = 0.1814$$

Inf₁ = 0.10 (years 1-5)Inf₂ = 0.07 (years 6-20)CF₁ = 0.185 (years 1-5)CF₂ = 0.157 (years 6-20)

The overall results are sensitive to the numerical values chosen for inflation and cost of capital. The derivations of these factors are given in Appendices D and E, respectively. The formula for annualizing the closure fund implicitly sets the rate of interest on the trust fund at the rate of inflation.

D. ECONOMIC IMPACT ANALYSIS METHODOLOGY.

Chapter II describes the overall approach to the economic impact analysis. This section provides more detail on the methodology used to calculate or estimate the individual impact parameters:

- Compliance cost as a percent of value added
- Plant closures
- Job losses
- U.S. production cutbacks
- Price increases
- U.S. demand reduction
- Balance of payments effects (shifts in import/export balances).

The analysis was performed in three major steps:

1. Revising the industry characterization and economic and financial models to reflect 1978 values. The characterization included the following data for each segment:

- Production value
- Production volume
- Number of producers
- Number of plants
- Four-firm concentration ratio
- Unit demand growth through 1983
- Degree of product substitution
- Degree of import competition
- Capacity utilization
- Profitability

2. Determining the incremental cost of ISS as a percent of value added, using 1978 figures. This impact measure has been calculated on an industry segment, subsegment, and model plant level as shown above.
3. Evaluating the economic impact quantitatively or qualitatively, using the following procedures.

1. High Impact Industries

EPA identified six industries (textile manufacturing, segments of inorganic and organic chemicals, leather tanning and finishing, nonferrous metal smelting and refining, and electroplating and metal finishing) at the beginning of this project

as ones that could experience significant economic impact. Quantitative economic impact analysis techniques were used to evaluate these industries. Economic and financial models were used to make numerical predictions of plant closure, job losses, and price change impacts. In general, the models used had been developed earlier for EPA effluent guideline projects and were updated for the ISS analysis.

The quantitative economic impact models employed capital budgeting analysis that firms often use when making new investment decisions. The cost structure of the representative model plants provided the baseline upon which the ISS compliance costs were imposed. The income statement and balance sheet of the model plant were changed to reflect the added compliance costs. The resulting financial condition of the plant was compared with the pre-RCRA condition for estimating the likelihood of a plant closure. The price increase required to return the model plant to pre-compliance levels of profitability was calculated, and the ability of plants to remain in operation after compliance expenditures, assuming no price increase, was assessed.

The specific methodologies for determining probable plant closures, a key part of the analyses, differed among the industries. Some closure analyses used the net-present-value approach, by which expected future cash flows were discounted at the firm's estimated cost of capital. A negative net-present value of the firm's future cash flow after the addition of the compliance costs implied that a profit-maximizing owner should liquidate the plant and reinvest the salvage proceeds at the cost of capital. Other closure analyses examined return on investment, coverage ratios, and other financial variables.

The projected model plant closures were extrapolated to the existing plants associated with the respective model plant. These closures were projected for the base case (without compliance expenditures) and the impact case (with compliance expenditures). If a plant was expected to close, independent of imposition of the regulation, it was not included in the estimate of ISS-induced plant closures.

In addition to a quantitative prediction of plant closures, job losses, and price changes, a qualitative assessment was made of demand reduction, production cut-backs, and balance of payments effects.

2. Other Industries

The economic impact of the regulations on the remaining 16 industries, as well as on some portions of the inorganic and organic chemical industries, was evaluated qualitatively. Arthur D. Little, Inc., staff with specific knowledge of the subject industry assessed the likelihood of a non-trivial change in the impact parameters as a result of the ISS compliance cost. Economic impacts were examined from two perspectives: 1) the chance that the impact would occur, and 2) the magnitude of the impact. Table V-6 shows the categories of impacts and impact descriptors used in this assessment.

TABLE V-6
DESCRIPTORS OF ECONOMIC IMPACTS USED IN THE
QUALITATIVE IMPACT ASSESSMENT

% Probability of Change in Impact Measure	% Change in Impact Measure	
	0-0.5	0.5 and Above
0.0	none	none
0-10	negligible	negligible
11-25	negligible	unlikely
26-50	negligible	possible
51-75	negligible	probable
76-100	negligible	likely

Source: Arthur D. Little, Inc.

The first consideration was whether all or only a portion of the compliance costs for an industry segment could be covered in product price changes. The magnitude of the price change required, the profitability of the industry segment, and the ability to increase prices led to a consideration of the likelihood of plant closures. The ability to increase prices was considered in light of the competitive environment of the industry segment as a whole and of differences among competitive plants in their ISS cost as a percent of value added. A significant difference in ISS compliance costs among competitive plants was considered one of the strongest signals that plant closures might occur. The evaluation of price increases and plant closures also included such factors as capacity utilization, real growth, competition from imports, and competition from substitute products. The role of price leadership was also taken into consideration, as well as supply and demand balances in highly fragmented industries.

The potential for plant closures depends on the nature of competition in the industry and the relation of the compliance cost to industry profitability. For each industry segment, profitability was estimated as a percent of value added for comparison with the compliance cost as a percent of value added. This comparison was made for each subcategory of each model plant within the industry segment. Closure estimates were made by considering price changes and the relation of compliance costs to profitability among competing plants. For model plants whose profitability will be eliminated even after allowing for price increases, the potential for the plants represented by the model to close is said to be "likely." Because cost and profitability values of the actual plants are both higher and lower than the average model plants, a significant reduction, though not elimination, of the model's profitability implies "possible" or "probable" plant closures. Moreover, some plants with long-term low profitability will be unable to finance capital and closure fund payments and will close even though their profit level is not completely eliminated.

The economic impacts resulting from differences in compliance costs among competing plants were also considered. Although price is not the only basis of competition, it is usually an important competitive factor. Price changes made by the price-leading plants often restrict other plants' ability to change prices. Ultimately, the inability of some plants to recover higher compliance costs can result in plant closures.

After determining the impact of the ISS on product prices and plant closures, a new supply and demand equilibrium was evaluated qualitatively and judgments were made about impacts on product demand, production, jobs, and the balance of payments. For example, lower demand brought about by higher prices could result in production cutbacks and job losses, even without plant closures. On the other hand, with strong import competition, a small price increase could result in a significant increase in imports. This, in turn, could lead to production cutbacks and job losses without affecting product demand.

VI. IMPACT ANALYSIS RESULTS

A. INTRODUCTION

The impacts of the RCRA ISS regulations on hazardous waste generating firms fall into two major categories:

- Costs of compliance, and
- Economic impacts resulting from the compliance costs.

This chapter presents a summary of the analysis of both types of impacts.

The discussion of the costs of compliance includes: 1) the total incremental compliance cost for the 22 industries analyzed, 2) total costs allocated by compliance activity and regulatory section, 3) annualized total compliance costs, 4) costs for small waste generators, 5) the results of a sensitivity analysis examining the effects of varying selected major assumptions, and 6) a summary of individual industry compliance costs.

Following the cost discussion is a summary of the economic impacts for all of the 22 industries. Details of each industry analysis appear in Appendix F. The Appendix contains an industry characterization and a summary of the economic impact for each industry. Salient industry data and impacts are collected in four similar tables in each industry analysis: 1) economic characterization, 2) financial profile, 3) incremental compliance costs, and 4) economic impact.

B. COSTS OF COMPLIANCE

1. Total Incremental ISS Compliance Cost

During the first year of the ISS, the 22 industries will spend \$840 million (pre-tax) on capital expenditures, initial (one-time) expenses, operating expenses, and contributions to funds for closure and post-closure care of land disposal sites (Table VI-1). The initial start-up expenses are 42% of the total, the largest single item. If the 1978 rate of waste generation were held constant and inflation neglected, the compliance cost would be \$321 million per year for years 2 through 20 of the ISS. The capital and initial expenses occur only in the first year. The subsequent-year costs are 38% of the total first-year costs. During the 20-year period covered by the analysis, the total expenditures in constant uninflated 1978 dollars would be just under \$7 billion. These costs include provisions for closure in the twentieth year and post-closure monitoring for another 30 years.

Inflation is included in the annualized compliance cost calculation (discussed below). The annualized costs are used in the economic impact analysis in addition to the total first-year costs. Inflation was assumed to be 10% per year for each of the first 5 years of ISS and 7% per year for years 6 through 20. Figure VI-1 displays the time series of expenditures, including inflationary effects.

TABLE VI-1
INCREMENTAL YEARLY ISS COMPLIANCE COSTS
(million 1978 \$)

	Years of the ISS			
	First Year	%	Subsequent Years ^a	%
Capital Costs	166.9	20		
Initial Expenses	352.0	42		
Closure-Fund Contribution	78.9	9	78.9	25
Annual Operating Costs				
On-Site Disposal	98.9	12	98.9	31
Off-Site Disposal	142.8	17	142.8	44
Total	839.5	100	320.6	100

a. Values do not reflect inflation.

Source: Arthur D. Little, Inc., estimates.

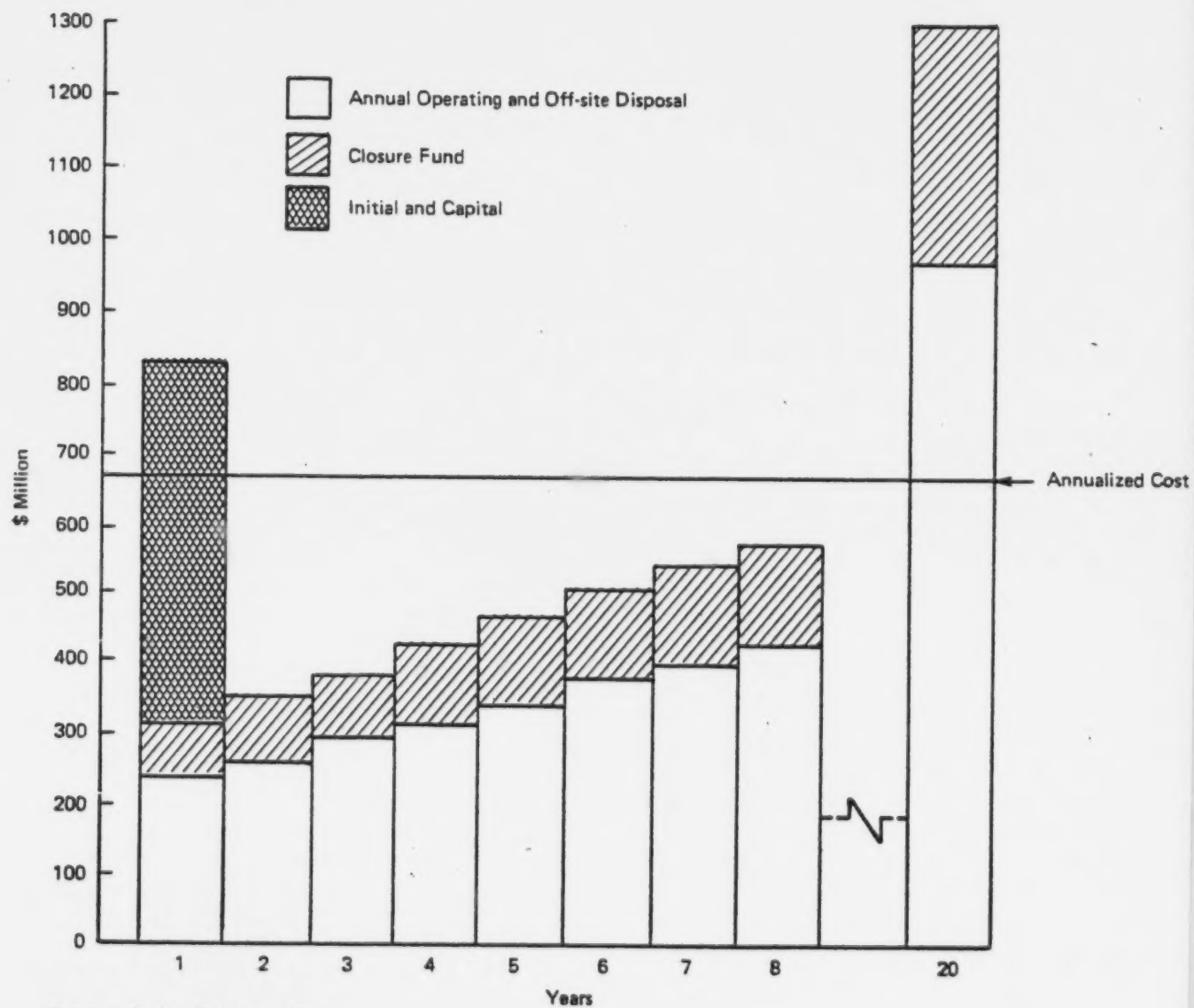
2. Costs Attributed to Compliance Activity and Regulatory Section

The total incremental compliance costs are an aggregation of costs for a large number of new activities and expenditures by hazardous waste generators as a result of the ISS. Table VI-2 shows the total costs, disaggregated into eight categories of compliance activities and four types of costs. Contributions of \$1.56 billion to the closure and post-closure funds are the largest single entry, followed by initial expenditures for testing waste streams at \$285 million.

Contingency preparation and such security measures as fencing and purchase of emergency equipment account for 66% of the capital costs. Installing ground-water monitoring wells is the other major item, accounting for 34%. Monitoring and testing costs are 81% of the one-time initial cost category. These costs include establishing a sampling plan and carrying out an initial analysis of all waste streams. One-time administrative costs account for 13% of the initial costs.

Increased prices for off-site disposal contribute 50% to recurring annual costs of compliance for generators. The incremental off-site disposal costs shown in this ISS analysis are the price changes for off-site disposal necessary to recover fully the incremental expenditures for the closure funds, testing, recordkeeping, training, etc., required of commercial disposal facilities. These price changes are reported as "off-site disposal" costs and, because they include all of the compliance activities, they are not parallel to "on-site disposal" costs.

The cost of transportation for off-site disposal was included in the RCRA cost analysis. During the ISS phase of the RCRA program, waste disposal technologies



Source: Arthur D. Little, Inc.

FIGURE VI-1 COMPLIANCE COSTS OVER TIME

TABLE VI-2
COMPLIANCE COSTS BY COMPLIANCE ACTIVITY
(million 1978 \$)

	On-Site Treatment and Disposal	Off-Site Treatment and Disposal ^a	Recordkeeping and Reporting	Monitoring and Testing	Administration	Training	Contingency	Closure Fund	Total
Capital	0.890	-	-	56.370	-	-	109.623	-	166.884
Initial	-	-	4.955	284.579	47.401	11.993	3.119	-	352.049
Annual	-	142.772	13.469	13.903	49.759	3.903	5.035	12.887	241.73
Closure	-	-	-	-	-	-	-	1,557.109 ^b	1,577.109

a. There are no incremental transportation costs for ISS.

b. This amount is the total uninflated closure and post-closure cost.

Source: Arthur D. Little, Inc., estimates.

do not have to be changed and waste generators will use the same off-site disposal facilities after ISS as before. Therefore, there are no incremental transportation costs as a result of ISS.

The off-site disposal costs would increase substantially over the figure shown, however, if disposers are forced to ship wastes longer distances to TSDFs. Disposal costs would also be higher if prices charged by TSDFs were increased by more than the proportionate change in the cost of operating the TSDF as a result of the ISS. This could occur in the case of value pricing where there is a shortage of disposal outlets.

The largest single entry in Table VI-2 is the closure-fund cost, consisting of the total closure and post-closure compliance activity costs. Major items in this figure include costs for capping and revegetating landfills and impoundments, decommissioning incinerators and tankage, and post-closure monitoring.

In Table VI-3 the compliance costs are assigned to Sections 3001, 3002, 3003, 3004 (ISS), and 3005 of the RCRA Subtitle C regulations. Although the Section 3004 requirements are only the Interim Status Standards, this section results in the majority of the compliance costs. Much of this total is due to the assignment of off-site disposal fees to Section 3004. After the first year, Section 3002 replaces Section 3001 as the second most costly section.

TABLE VI-3
COMPLIANCE COSTS BY REGULATORY SECTION
(million 1978 \$)

	3001	3002	3003	3004 (ISS)	3005	Total
Capital	—	—	—	166.884	—	166.884
Initial	292.896	21.037	—	29.975	8.139	352.049
Annual	1.388	24.493	0.289	216.560 ^a	—	241.731
Closure	—	—	—	1,577.109 ^b	—	1,577.109

a. Includes \$109.9 million for off-site disposal.

b. Total uninflated closure and post-closure cost over 20 years.

Source: Arthur D. Little, Inc., estimates.

3. Annualized Total Compliance Costs

The incremental ISS compliance costs are not the same from year to year. To smooth the uneven expenditures, the costs were converted to a single, annualized cost. First they were projected over 20 years, including inflation, and the present value of the sum was calculated in 1978 dollars. Second, the present value was

converted to an annuity of 20 equal yearly payments with a 1978 present value equal to that of the ISS compliance costs. The annuity payment is called the annualized cost. This smoothed form of the incremental cost is more comparable with the long-run average level of business activity, e.g., sales or value added, than is the actual cost in any single year. The first-year costs are greater and may result in plant closures in historically low-profit industry segments.

The total incremental annualized ISS compliance cost is \$665 million per year for the 22 industries studied (Table VI-4). This annualized cost before taxes is expressed in 1978 dollars. The recurring incremental cost of off-site disposal is the largest entry, accounting for 39% of the total. On an annualized basis, the largest single entry in the previous tables, the closure fund requirement, is next, about one quarter of the total. Training and contingency planning, largely start-up costs, are much smaller parts of the annualized total.

TABLE VI-4
TOTAL ANNUALIZED INCREMENTAL COSTS OF
ISS COMPLIANCE BY COMPLIANCE ACTIVITY
(millions 1978 \$)

Compliance Activity	Annualized Cost ^a	Percent of Total (%)
On-Site Treatment and Disposal	0.16	—
Closure Fund ^b	164	25
Off-site Transportation/ Disposal ^c	256	39
Recordkeeping/Reporting	25	4
Monitoring/Testing	84	13
Administration	97	15
Training	9	1
Contingency Planning	29	4
Total	665 ^d	100 ^d

a. The annualized cost is a 20-year annuity whose present value equals the present value of 20 years of uneven ISS compliance costs.

b. Contributions to a fund providing for final closure and post-closure monitoring and maintenance of waste disposal sites.

c. There are no incremental transportation costs.

d. Does not add due to rounding.

Source: Arthur D. Little, Inc., estimates.

The compliance costs attributable to the regulation sections are annualized in Table VI-5. Off-site disposal fees are 45% of the cost attributed to Section 3004 and 38% of the total cost. Testing is responsible for a large part, about two thirds, of the incremental off-site disposal costs. Price increases attributable to facility costs,

TABLE VI-5
ANNUALIZED ISS COMPLIANCE COSTS BY REGULATION SECTION
(million 1978 \$)

Section of Regulation	On-Site Treatment and Disposal	Off-Site Treatment and Disposal	Recordkeeping and Reporting	Monitoring and Testing	Administration	Training	Contingency	Closure	Total
3001	-	-	-	48.333 (7.3)	5.217 (0.8)	-	-	-	53.550 (8.1)
3002	-	-	18.320 (2.7)	-	27.427 (4.1)	-	-	-	45.748 (6.9)
3003	-	-	-	-	0.519 (-)	-	-	-	0.519 (-)
3004	0.155 (-) ^a	255.733 (38.4)	6.029 (0.9)	36.013 (5.4)	63.737 (9.6)	9.083 (1.4)	28.387 (4.3)	164.328 (24.7)	563.468 (84.8)
3005	-	-	0.640 (-)	-	0.490 (-)	-	0.288 (-)	-	1.419 (0.2)
Total	0.155 (-)	255.733 (38.4)	24.990 (3.7)	84.346 (12.7)	97.391 (14.7)	9.083 (1.4)	28.675 (4.3)	164.328 (24.7)	664.706 (100)

a. Figures in () are percentages of total (\$664.706).

Source: Arthur D. Little, Inc., estimates.

closure costs, administrative costs, and all other non-testing costs at TSDFs contribute only about one-third to this recurring compliance cost.

The annualized closure cost can be split into two components: costs attributable to the costs of closure and post-closure (Subpart G of Part 265), and additional costs imposed by the financial requirements (Subpart H of Part 265). The present value of the closure and post-closure costs (\$1,577.109 million in uninflated 1978 dollars), assuming all post-closure monies are expended in the twentieth year, is \$336.491 million.* The present value of the financial requirements portion is \$569.396 million, almost two-thirds of the total closure requirements.

The financial burden results from the requirement to build up the closure fund during the 20 years prior to the actual expenditures for closure. The return on the fund's investments and its tax treatment will also determine the level of a generator's yearly contribution to the fund. Several mechanisms are available to generators, including asset tests, letters of credit and managed trust funds. For this analysis, a trust fund was assumed whose rate of return (after taxes) is equal to inflation. The fund is assumed to be invested in government bonds whose interest rate on a long-term basis has approximately equaled the inflation rate.

The present value of 20 years of all the ISS compliance costs is \$3.66 billion in 1978 dollars, about 0.3% of the present value of the value added by the included industry segments over the 20-year period, assuming value added inflates at the same rate as the compliance cost.

4. Small Waste Generators

The ISS excludes small waste generators (SWGs) from most requirements applicable to larger generators. About 22,000 SWGs generate an average of 4.2 MT of regulated waste annually in the 22 industries. As part of the cost-of-compliance analysis, the ISS waste generated by these plants and shipped to off-site disposal was assigned the same incremental ISS off-site disposal compliance cost as the other ISS waste. The analysis assumed that SWGs with hazardous waste would be required to use RCRA-compliant disposal outlets rather than municipal landfills or other uncontrolled facilities.

Using this assumption, SWGs will bear \$91.0 million (Table VI-6) of annualized compliance cost, about 14% of the total annualized incremental cost of the regulations. The plants have annualized costs averaging \$4270. This cost, as a percent of 1978 value added, is about 20% higher than that for all 43,400 plants. The average cost per MT is \$1017, compared with \$136 per MT for all plants, because of the high annual fixed costs for testing at the TSDFs. Virtually all SWG waste is sent to commercial off-site disposal facilities (TSDFs).

If the complete ISS costs are applied to the SWGs, the total annualized cost would be \$240 million. This value is 2% of the SWGs' value added and would be a

*This simplifying assumption introduces a minor error in the calculations, as the post-closure costs extend 30 years beyond closure. The financial requirements portion is slightly understated as a result.

TABLE VI-6
ANNUALIZED ISS COSTS FOR SMALL WASTE GENERATORS^a

Compliance Costs For SWGs	Total Annualized Cost (Million \$)	Annualized Cost Per Plant ^b	Annualized Cost Per MT ^b	Annualized Cost As Percent of 1978 Value Added ^c
Base Case	91.0	\$ 4,270	\$1,017	0.73%
Full ISS Costs	240.1	\$11,324	\$2,693	2.0%

a. Plants with less than 1000 kg/month (12 MT/yr) of hazardous waste.

b. 21,194 plants with 89,000 MT of ISS regulated waste.

c. Value added for all SWGs.

Source: Arthur D. Little, Inc., estimates.

significant cost for the plants. The full ISS costs are \$2700 per MT for the SWGs. Generators may see this cost as an exorbitant expense for disposal of very small waste quantities. Even the \$1017 per MT disposal fees are a significant disincentive to sending the waste to controlled facilities.

The cost values in Table VI-6 do not include the annualized costs for about 200 SWGs in the textile, leather, nonferrous metal smelting, and inorganic chemical industries, which have about 680 MT of waste. Their exclusion does not change the general conclusions, however. Furthermore, the value added for the SWG group used to calculate the annualized cost as a percent of value added contained the value added of 3000 plants having no ISS costs because they have no ISS waste. These plants are mostly in the agricultural services industry. As a result, the average cost per plant for SWGs having ISS waste is understated.

5. Compliance Cost Sensitivity Analysis and Discussion

The ISS compliance costs do not change dramatically with large alterations in the financial assumptions, the industry data base, or unit cost of compliance, with the exception of changes in the number of waste generators included in the analysis (Table VI-7). Doubling the number of generators more than doubles the compliance costs.

Reducing the quantity of waste by 20% decreases the annualized cost by only 5% and the total first-year cost by 3%. Therefore, the costs do not provide a substantial incentive for reducing the volume of waste generated, although there is an economic incentive for a generator to stop waste generation completely and thereby eliminate all RCRA compliance costs.

Altering the time allowed for building up the closure and post-closure funds does not change the annualized costs appreciably. Reducing the time from 20 years

TABLE VI-7
SENSITIVITY OF ISS COMPLIANCE COSTS TO CLOSURE FUND
BUILD-UP PERIOD AND SELECTED DATA BASE ASSUMPTIONS
(million 1978 \$)

Sensitivity Variable	First-Year Only Costs			Annual Costs		Total First-Year Expenditures	Annualized Cost ^a	Percent Change of Annualized Cost from Base Case
	Capital	Initial	Closure Fund	Operating	Off-Site Trans. and Disposal			
Base Case	166.9	352.11	78.9	98.9	142.8	839.5	664.7	-
Closure Fund Period = 1 Yr. ^b	166.9	352.11	1,577.1	98.9	142.8	2,337.8	789.0	19
Closure Fund Period = 5 Yrs. ^b	166.9	352.11	315.4	98.9	142.8	1,076.1	753.6	13
Waste Quantity X 0.8	161.0	347.8	74.8	95.3	134.8	813.7	634.6	-5
Waste Quantity X 2	177.1	356.3	88.0	105.3	191.0	917.7	781.3	18
Off-Site Price X 2	166.9	352.1	315.4	98.9	164.4	861.2	703.5	6
Off-Site Price X 5	166.9	352.1	315.4	98.9	229.4	926.2	819.9	23
Testing Cost X 2	166.9	352.1	315.4	98.9	148.6	845.3	675.1	2
Testing Cost X 0.5	166.9	352.1	315.4	98.9	139.9	836.6	659.5	-1
No. of Generators X 2	333.6	704.1	157.7	197.9	305.2	1,699	1,365	105
No. of Generators X 0.8	128	281.6	63.1	78.8	110.3	661.9	523.2	-21

a. The annualized cost is a 20-year annuity whose present value equals the present value of 20 years of uneven ISS compliance costs.

b. Number of years allowed for completing contributions to the closure fund; the base case is 20 years.

Sources: Arthur D. Little, Inc., estimates.

to 5 years increases the annualized cost by 19%. Reducing the period further to one year increases the annualized cost by only an additional 5%. On the other hand, the total first-year costs are changed considerably by this assumption; for many plants with limited financial resources, the first-year costs would be difficult to absorb. The total first-year cost may be a more important determinant of economic impact in this case than the annualized cost.

Large changes in the level of waste generation at which it is assumed that the waste would be shipped to off-site disposal do not change the compliance costs significantly. For all industries except leather tanning and some organic chemical products, waste was assigned to off-site disposal if the amount of waste generated by the model plant was less than a specified value for each disposal technology. That amount of waste (in metric tons) at which waste would be sent off site is called the off-site breakpoint; lowering the breakpoints has the effect of assigning on-site disposal costs to more waste. Lowering all the breakpoints by 50% increases the annualized compliance cost by only 5% (Table VI-8), and doubling them does not change the cost.

TABLE VI-8
SENSITIVITY OF ANNUALIZED ISS COSTS TO OFF-SITE BREAKPOINT VOLUME^a

Breakpoint Volume Multiplier ^b	Annualized Compliance Cost (Million \$)
0.05	762
0.2	733
0.5	695
1.0 (Base Case)	665
2.0	665
4.0	681

a. Waste generation rate for each disposal technology below which waste is sent to off-site disposal.

b. Multiplier applied to the breakpoint value of each disposal technology.

Source: Arthur D. Little, Inc., estimates.

The assumed inflation rate also has very little influence on the annualized compliance cost (Table VI-9). Reducing the base case inflation rate of 10% in years 1 through 5 and 7% in years 6 through 20 to 7% and 5%, respectively, drops the annualized cost by only 9%. The inflation rate is included in interest earned on the closure funds, meaning that the present value of the fund is not changed by inflation. Because the cost of capital includes inflation, future inflated costs are discounted at higher rates as inflation rises.

TABLE VI-9

SENSITIVITY OF ANNUALIZED ISS COMPLIANCE
COSTS TO FINANCIAL ASSUMPTIONS

Inflation Rate (%) (Years 1-5/6-20)	5%	Real Cost of Capital ^a	
		9.3%	15%
7/5	670.4	604.6	532.7
10/7	739.9	664.6 ^b	580.4
12/12	856.2	759.2	651

a. The cost of capital approximates the inflation rate plus the real cost of capital.

b. Base case.

Source: Arthur D. Little, Inc., estimates.

The real cost of capital assumption (which excludes inflation) does affect the annualized cost, however, because a higher real cost of capital reduces the present value of future compliance costs. As a result, raising the real cost of capital from 9.3% to 15% reduces the annualized compliance cost to \$580 million from \$665 million.

6. Summary of Individual Industry Compliance Costs

RCRA ISS will impose the highest annualized cost on the agricultural services industry (pesticide application) with \$141 million (Table VI-10). These high costs are due to the industry having 23,000 establishments, almost half of the plants in all industries studied. The electroplating and petroleum refining industries rank second and third in annualized cost among the 22 industries. On the basis of the total first-year costs, the agricultural services industry ranks first, with \$202 million, followed by electroplating at \$161 million, and electronic components at \$81 million.

The annualized compliance costs range from \$277,000 per plant in the petroleum refining industry to \$1700 per plant in the chemical wholesaling industry (Table VI-11). The weighted average cost per plant generating ISS-regulated waste is \$15,300. The cost-per-plant values are high for plants with large on-site disposal activities, such as inorganic chemicals, petroleum rerefining, and nonferrous metal smelting. Industries shipping most of their waste to commercial disposal facilities have relatively higher annualized costs than total first-year costs.

The annualized cost per MT of waste is highest for industries with low waste generation rates. The highest cost is for the chemical wholesaling industry at \$1200 per MT. Wood preserving and electronic components rank second and third, with \$930 and \$530 per MT, respectively. The weighted average cost per metric ton of

TABLE VI-10

INCREMENTAL ISS COMPLIANCE COSTS BY INDUSTRY
(million 1978 \$)

Industry	First-Year ^a		Annual ^a			Total First-Year Expenditure ^a	Annualized Cost ^b
	Capital	Initial Expenses	Closure Fund	Operating	Off-Site Treatment & Disposal		
Agricultural Services	22.97	113.44	1.24	34.86	29.15	201.68 (1) ^c	140.67 (1)
Textile Manufacturing	15.22	5.34	2.30	5.33	2.45	30.66 (8)	21.67 (6)
Wood Preserving	1.96	1.87	0.69	0.66	0.35	5.54	3.73
Inorganic Chemicals	6.90	3.65	2.78	1.55	5.38	20.30	19.27
Plastics	6.55	3.02	10.09	1.51	3.60	24.78 (10)	28.91 (7)
Pharmaceuticals	1.43	5.82	1.04	0.81	2.14	11.27	8.44
Paints and Allied Products	3.71	19.34	1.05	3.26	5.48	32.86 (7)	21.57
Organic Chemicals	1.32	0.98	1.22	0.51	2.10	6.17	7.31
Pesticides	9.01	3.16	8.72	2.24	4.40	27.55 (9)	29.66 (6)
Explosives	3.13	0.18	3.25	0.29	0.00	6.86	6.93
Petroleum Refining	19.41	13.64	21.54	5.39	13.94	73.94 (4)	78.99 (3)
Petroleum Rerefining	1.63	0.60	0.87	0.30	0.17	3.59	2.82
Rubber Products	3.14	5.41	1.09	1.92	1.65	13.23	9.85
Leather Tanning and Finishing	2.41	3.02	0.60	1.53	10.55	18.12	23.67 (9)
Ferrous Metal Smelting and Refining	10.32	7.49	6.07	4.80	7.71	36.43 (6)	36.43 (5)
Nonferrous Metal Smelting and Refining	5.45	2.08	2.48	1.44	2.68	14.15	13.15
Electroplating and Metal Finishing	42.18	64.33	10.55	23.92	19.81	160.81 (2)	115.81 (2)
Special Machinery	2.50	32.94	0.31	2.87	9.16	47.81 (5)	28.32 (8)
Electronic Components	4.93	54.53	1.97	3.73	15.33	80.50 (3)	40.04 (4)
Batteries	2.22	2.03	0.88	1.29	3.38	9.82	10.71
Drum Reconditioning	0.39	0.72	0.02	0.56	0.88	2.58	2.81
Chemical Wholesaling	0.00	8.32	0.00	0.08	2.35	10.77	5.83
Total^d	166.88	352.05	78.85	98.95	142.77	839.52	664.70

a. Million 1978 dollars.

b. The annualized cost is a 20-year annuity whose present value equals the present value of uneven ISS compliance costs.

c. () rank from the highest.

d. Totals do not add due to rounding.

Source: Arthur D. Little, Inc., estimates.

TABLE VI-11

ISS COMPLIANCE COSTS PER PLANT AND PER METRIC TON

Industry	Annualized Cost Per Plant ^a	Annualized Cost Per Metric Ton ^b
Agricultural Services	\$ 8,608	\$ 419 (4) ^c
Textile Manufacturing	39,045	99
Wood Preserving	8,144	933 (2)
Inorganic Chemicals	173,600 (2)	6
Plastics	50,630	51
Pharmaceuticals	6,807	73
Paint & Allied Products	15,687	207
Organic Chemicals	64,690	1
Pesticides	55,962	42
Explosives	—	—
Petroleum Refining	277,160 (1)	41
Petroleum Rerefining	122,610 (4)	35
Rubber Products	5,760	186
Leather Tanning and Finishing	88,652 (5)	38
Ferrous Metal Smelting and Refining	32,210	30
Nonferrous Metal Smelting and Refining	158,430 (3)	25
Electroplating and Metal Finishing	15,849	58
Special Machinery	9,077	383 (5)
Electronic Components	11,172	528 (3)
Batteries	40,722	24
Drum Reconditioning	14,050	38
Chemical Wholesaling	1,715	1,166 (1)
Weighted Average	15,321	36

a. Includes only plants with ISS waste.

b. Includes only ISS waste.

c. () Rank from the highest.

Source: Arthur D. Little, Inc., estimates.

ISS-regulated waste is \$36. This value reflects the \$6 per metric ton average for inorganic chemicals and \$1 per metric ton for organic chemicals. These industries together have 50% of the total ISS-regulated waste. Compliance costs for individual segments are included in the economic impact discussion of each industry in Appendix F.

C. ECONOMIC IMPACT ANALYSIS RESULTS

Economic impact estimates are based on a model plant financial analysis for the high-impact industries and a qualitative assessment of potential impacts for the remaining industries. Comparing the annualized compliance cost to the 1978 value

added was an important element of the qualitative assessment. Value added, defined as the value of shipments less the cost of raw materials, is a better measure of the magnitude of business activity than is sales when comparing business activities among different industries. Thus, the annualized compliance cost as a percent of value added is a useful measure of the regulation's potential for economic impact over the long run. In the short run, high first-year costs may result in plant closures in cash-short industry segments with historically low profitability and limited access to new financing.

In the following tables and discussion, two ratios of compliance cost to value added appear. One is the ratio of annualized compliance cost to the 1978 value added, the parameter used in the qualitative analysis. The second is the ratio of annualized cost to the value added, adjusted over the same twenty years, assuming an identical rate of inflation and capital factor. The second ratio is equal to the first, divided by 1.791.

Table VI-12 shows both sets of ratios. The value-added figures represent the output of all the plants in the analysis (51,000), including about 7000 with no ISS-regulated waste. Pretax profits are typically 5-20% of value added. A plant with an operating cost increase as a result of ISS comparable to its profits is in danger of closing if prices cannot be increased to compensate. Price increases, on the other hand, will tend to lower demand for the plant's products. The economic impact analysis considered these tradeoffs in light of the economic conditions of the industry.

Looking at whole industries, agricultural services and petroleum rerefining exhibit the largest annualized cost as a percentage of adjusted value added, both around 6%. Leather tanning and finishing is next, with an industry-wide figure of about 4%. No other industry has a percentage exceeding 2%. Seventeen industries have costs less than 1% of adjusted value added. The weighted average percentage for all 22 industries is also small, 0.34%.

Moving from cost impacts for industries as a whole to the cost for the 109 industry segments (Table VI-13) shifts the perceived locus of potential economic impacts. Fourteen segments or industries with 1978 value added of \$2.3 billion will have annualized ISS compliance costs greater than 3% of 1978 value added, or about 1.7% of adjusted value added. Half are in the leather tanning industry. The others in this potentially high-impact group include the whole agricultural services industry, the petroleum rerefining industry, and segments of the electroplating, plastics, and inorganic chemical industries. The captive-indirect* segment of the electroplating industry is expected to incur the highest cost impact, with an annualized cost of 29% of 1978 value added.

Moderate impacts, where the cost of compliance is 1-3% of 1978 value added, are expected for 22 industry segments totaling \$6.7 billion in value added. The

*indirect wastewater dischargers. These are plants discharging wastewater to municipal treatment systems.

TABLE VI-12
INDUSTRY IMPACTS – ANNUALIZED COSTS
AS A PERCENT OF VALUE ADDED

Industry	Annualized Cost as a Percent of 1978 Value Added	Annualized Cost as a Percent of Adjusted Value Added
Agricultural Services	11.72 (1) ^a	6.52
Textile Manufacturing	0.45	0.25
Wood Preserving	1.00 (9)	0.56
Inorganic Chemicals	2.53 (4)	1.41
Plastics	1.24 (7)	0.69
Pharmaceuticals	0.09	0.05
Paint & Allied Products	0.68	0.35
Organic Chemicals	0.82	0.46
Pesticides	1.14 (8)	0.64
Explosives	1.58 (5)	0.88
Petroleum Refining	0.55	0.31
Petroleum Rerefining	10.85 (2)	6.06
Rubber Products	0.11	0.06
Leather Tanning & Finishing	6.90 (3)	3.85
Ferrous Metal Smelting and Refining	0.55	0.31
Nonferrous Metal Smelting and Refining	1.28 (6)	0.71
Electroplating & Metal Finishing	0.38	0.21
Special Machinery	—	—
Electronic Components	0.43	0.24
Batteries	0.78	0.44
Drum Reconditioning	0.94 (10)	0.52
Chemical Wholesaling	0.36	0.02
Weighted Average	0.61	0.34

a. () Rank from the highest

Source: Arthur D. Little, Inc., estimates.

remaining 73 segments will probably incur low to negligible cost impacts of less than 1% of 1978 value added. Although the segment cost impact appears low in this last group, some individual plants could be threatened by higher-than-average costs or by historic low profit levels.

Compliance cost as a percentage of value added is only an indicator of potential economic impacts, expressed as plant closures, job losses, price increases, and other measures. The more direct impact measures were assessed quantitatively for the six high-impact industries and qualitatively for the remainder. The details of these evaluations are given in Appendix F. Table VI-14 summarizes the results for all 22 industries, reporting each segment separately.

TABLE VI-13

RANKING OF INDUSTRY SEGMENTS BY ANNUAL
COMPLIANCE COST AS PERCENT OF 1978 VALUE ADDED

Industry Segment	% of 1978 Value Added	1978 Value Added (\$ Million)
More Than 3%		
Electroplating: Captive - Indirect	29.08	119.6
Leather Tanning and Finishing: Retan - Wet Finish	25.26	17.0
Leather Tanning and Finishing: Chrome Tan, Save Hair	12.29	8.0
Plastics: Phenolic Resins	11.86	188.0
Agricultural Services	11.72	1,200.0
Petroleum Rerefining	10.85	26.0
Leather Tanning and Finishing: No Beamhouse	8.14	19.0
Leather Tanning and Finishing: Through-The-Blue	7.22	25.0
Leather Tanning and Finishing: Chrome Tan - Pulp Hair	6.28	209.0
Inorganic Chemicals: Chrome Pigments	3.58	27.1
Inorganic Chemicals: Titanium Dioxide-Sulfate Process	3.50	104.8
Leather Tanning and Finishing: Nonchrome Tan	3.32	29.0
Electroplating: Captive - Direct	3.15	393.2
Leather Tanning and Finishing: Leather Finishers	3.07	25.0
1.0 - 3.0%		
Nonferrous Metals: Primary Zinc	2.76	72.1
Inorganic Chemicals: Chlor-Alkali-Mercury Cell Process	2.50	139.9
Explosives: High Explosives	2.48	29.0
Inorganic Chemicals: Sodium Dichromate	2.44	45.9
Organic Chemicals: Furfural	2.28	40.0
Inorganic Chemicals: Chlor-Alkali-Diaphragm Cell Process	2.26	319.6
Pesticides: Active Ingredients	1.92	1,235.0
Nonferrous Metals: Primary Lead	1.77	55.5
Leather Tanning and Finishing: Shearlings	1.70	11.0
Explosives: Blasting Agents	1.52	410.0
Electroplating: Job Shops - Indirect	1.49	1,405.5
Nonferrous Metals: Secondary Lead	1.48	95.4
Organic Chemicals: Toluene Diisocyanate	1.46	110.0
Textiles: Wool Finishing - Direct	1.45	45.0
Electroplating: Job Shops - Direct	1.42	154.5
Textiles: Woven Fabric Finishing - Simple - Direct	1.32	147.8
Inorganic Chemicals: Titanium Dioxide-Chloride/ Chloride Ilmenite Process	1.24	208.4
Organic Chemicals: Acrylonitrile	1.24	166.8
Textiles: Woven Fabric Desizing - Direct	1.14	403.1
Textiles: Stock and Yarn Finishing - Direct	1.11	170.0
Batteries: Storage Batteries	1.02	1,006.2
Wood Preserving	1.00	374.0
0.50 - 0.99%		
Textiles: Knit Hosiery Finishing - Direct	0.98	15.4
Textiles: Wool Finishing - Indirect	0.95	63.0
Drum Reconditioning	0.94	300.0

TABLE VI-13 (Continued)

Industry Segment	% of 1978 Value Added	1978 Value Added (\$ Million)
0.50 - 0.99% (Continued)		
Ferrous Metals: Ferroalloys	0.86	290.0
Textiles: Carpet Finishing - Direct	0.86	109.5
Plastics: Acrylic Fibers	0.80	245.0
Textiles: Woven Fabric Finishing - Complex - Direct	0.75	156.9
Electroplating: Captive - Direct - Large	0.71	1,193.9
Organic Chemicals: Chlorobenzene	0.69	24.0
Paints and Allied Products	0.68	3,150.0
Special Machinery Industry: Special Industry Machines	0.67	3,535.0
Ferrous Metals: Iron & Steel - Non-Integrated and Mini Mills	0.66	925.7
Textiles: Knit Fabric Finishing - Complex - Direct	0.65	102.3
Electroplating: Captive - Indirect - Large	0.64	5,769.2
Plastics: Amino Resins	0.59	96.0
Textiles: Knit Fabric Finishing - Simple - Direct	0.57	377.5
Inorganic Chemicals: Boric Acid	0.56	23.0
Petroleum Refining	0.55	14,274.2
Nonferrous Metals: Primary Aluminum	0.55	1,323.0
Textiles: Stock and Yarn Finishing - Indirect	0.50	355.3
0.0 - 0.49%		
Pharmaceuticals: Medicinals and Botanicals	0.47	1,389.0
Organic Chemicals: Ethanolamines	0.45	57.0
Pesticides: Formulators	0.43	1,360.0
Plastics: Coumarone-Indene	0.43	27.0
Electronic Components	0.43	11,284.0
Plastics: Polystyrene	0.42	336.0
Organic Chemicals: Methyl Methacrylate	0.41	137.0
Organic Chemicals: Maleic Anhydride	0.38	42.0
Nonferrous Metals: Primary Copper	0.37	380.0
Chemical Wholesaling	0.36	1,600.0
Textiles: Woven Fabric Finishing - Simple - Indirect	0.35	324.0
Plastics: Alkyd Resins	0.34	68.0
Ferrous Metals: Gray Iron Foundries - Noncaptive	0.33	1,417.8
Textiles: Felted Fabric Processing - Indirect	0.30	2.7
Organic Chemicals: Nitrobenzene	0.30	85.0
Textiles: Knit Hosiery Finishing - Indirect	0.28	292.3
Plastics: Polypropylene Resins	0.27	232.0
Plastics: Rayon Fibers	0.27	358.0
Organic Chemicals: Lead Alkyls	0.26	262.0
Inorganic Chemicals: Phosphorus Pentasulfide	0.24	24.0
Textiles: Woven Fabric Finishing - Complex - Indirect	0.24	346.2
Textiles: Woven Fabric Desizing - Indirect	0.22	194.2
Ferrous Metals: Iron and Steel - Coke/Iron	0.22	253.4
Plastics: Neoprene	0.21	84.0
Organic Chemicals: Benzylchloride	0.21	15.0
Ferrous Metals: Malleable Iron Foundries - Captive	0.21	230.0
Ferrous Metals: Malleable Iron Foundries - Noncaptive	0.18	295.7

TABLE VI-13 (Continued)

Industry Segment	% of 1978 Value Added	1978 Value Added (\$ Million)
0.0 - 0.49% (Continued)		
Rubber: Other Rubber & Plastic Products	0.18	3,600.0
Ferrous Metals: Gray Iron Foundries - Noncaptive	0.18	538.3
Ferrous Metals: Iron & Steel - Alloy and Specialty Steel	0.18	2,209.5
Textiles: Knit Fabric Finishing - Simple - Indirect	0.17	776.6
Organic Chemicals: Chloromethanes and Perchloroethylene	0.16	170.2
Organic Chemicals: Epichlorohydrin	0.15	64.0
Ferrous Metals: Iron and Steel - Rerollers	0.13	1,449.5
Plastics: ABS/SAN Resins	0.13	297.0
Textiles: Knit Fabric Finishing - Complex - Indirect	0.12	359.4
Special Machinery: Office Computing and Accounting Machines	0.12	3,900.0
Batteries: Primary Batteries	0.11	368.3
Ferrous Metals: Iron & Steel - Integrated	0.11	10,341.0
Organic Chemicals: Ethylene Dichloride and Vinyl Chloride Monomer	0.10	209.5
Pharmaceuticals: Biological Products	0.10	607.0
Nonferrous Metals: Secondary Copper	0.07	121.0
Ferrous Metals: Ductile Iron Foundries - Noncaptive	0.07	1,073.7
Inorganic Chemicals: Phosphorus Trichloride	0.06	29.5
Rubber: Tires & Inner Tubes	0.06	5,200.0
Ferrous Metals: Ductile Iron Foundries - Captive	0.06	411.7
Ferrous Metals: Gray Iron Foundries - Large - Captive	0.06	1,361.7
Plastics: SB Rubber	0.06	278.0
Textiles: Nonwoven Manufacturing - Direct	0.05	38.3
Textiles: Wool Scouring - Indirect	0.05	18.0
Ferrous Metals: Gray Iron Foundries - Large - Noncaptive	0.05	2,651.0
Textiles: Nonwoven Manufacturing - Indirect	0.03	108.7
Textiles: Felted Fabric Processing - Indirect	0.03	54.0
Pharmaceuticals: Pharmaceutical Preparations	0.02	7,728.0
Textiles: Carpet Finishing - Indirect	0.01	353.5
Organic Chemicals: Fluoromethanes	0.01	160.0
Plastics: Polybutadiene	0.01	121.0
Textiles: Wool Scouring - Direct	< 0.01	47.8
Nonferrous Metals: Primary Mercury	< 0.01	1.0
Nonferrous Metals: Primary Tungsten	< 0.01	10.2
Nonferrous Metals: Secondary Aluminum	< 0.01	319.0
TOTAL	0.61	107,634.0

Source: Arthur D. Little, Inc., estimates.

TABLE VI-14

ECONOMIC IMPACT OF RCRA ISS REGULATIONS ON 22 INDUSTRIES BY INDUSTRY SEGMENT

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Agricultural Services (Custom Applicators) (SIC 0711, 0721, 0729)	22,700	likely	probable	negligible	likely	negligible	none
Textile Manufacturing							
Wool Finishing (SIC 2231)	37	0	0	0	none	none	none
Knit Simple (SIC 2251)	231	0	0	0	none	none	none
Knit Complex (SIC 2251)	48	0	0	0	none	none	none
Knit Hosiery (SIC 2251)	161	6	1,370	3.7 ^a	none	none	none
Woven Simple (SIC 2261)	206	10	410	7.3	none	none	none
Woven Complex (SIC 2261)	71	0	0	0	none	none	none
Woven Desizing (SIC 2261)	59	0	0	0	none	none	none
Stock & Yarn Finishing (SIC 2269)	218	1	160	2.2	none	none	none
Carpet Finishing (SIC 2272)	58	0	0	0	none	none	none
Felted Fabric Processing (SIC 2291)	20	0	0	0	none	none	none
Nonwoven Manufacturing (SIC 2297)	39	0	0	0	none	none	none
Wool Scouring (SIC 2299)	17	0	0	0	none	none	none
Wood Preserving (SIC 2491)	458	possible	possible	negligible	likely	negligible	none
Inorganic Chemicals							
Chlor-Alkali							
Mercury Cell							
1) ^b	11	9	153	0	11.6%	0	0
2)	14	0	0	0	2.5	0	0
3)	2	0	0	0	1.8	0	0
Chlor-Alkali							
Diaphragm Cell ^c							
1)	12	2 ^d	46	0	2.1	0	0
2)	17	0	0	0	1.0	0	0
3)	11	0	0	0	1.0	0	0

TABLE VI-14 (Continued)

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Inorganic Chemicals (Continued)							
Chromic Pigments							
1)	5	0	0	0	1.1%	0	0
2)	3	0	0	0	0.6	0	0
3)	2	0	0	0	0.4	0	0
4)	2	0	0	0	0.3	0	0
Titanium Dioxide-Chloride							
1)	3	0	0	0	1.2	0	0
2)	2	0	0	0	1.0	0	0
3)	1	0	0	0	0.2	0	0
Titanium Dioxide-Sulfate							
1)	2	2	562	0	4.2	0	0
2)	1	0	0	0	2.0	0	0
3)	1	0	0	0	1.2	0	0
Titanium Dioxide-Ilmenite							
1)							
2)							
3)							
4)							
Sodium Dichromate							
1)	3	0	0	0	0.4	0	0
2)							
3)							
4)							
Boric Acid							
1)	1	0	0	0	15.7	0	0
2)	1	0	0	0	4.7	0	0
3)	1	0	0	0	0.9	0	0
Phosphorous Pentasulfide	4	possible	possible	possible	probable	probable	negligible
Phosphorous Trichloride	8	unlikely	unlikely	unlikely	possible	possible	negligible
	7	negligible	negligible	negligible	negligible	negligible	negligible

TABLE VI-14 (Continued)

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Plastic Materials, Synthetic Rubbers, and Synthetic Fibers							
Phenolic Resins	120	probable	possible	none	likely	negligible	none
Amino Resins	215	none	none	none	negligible	none	none
Coumarone-Indene Resins	4	none	none	none	negligible	none	none
Polystyrene Resins	36	none	none	none	unlikely	none	none
Polypropylene	15	none	none	none	unlikely	none	none
ABS/SAN Resins	13	none	none	none	negligible	none	none
Alkyd Resins	140	none	none	none	negligible	none	none
SB Rubber	9	none	none	none	negligible	none	none
Polybutadiene Rubber	5	none	none	none	none	none	none
Neoprene Rubber	3	none	none	none	negligible	none	none
Rayon Fibers	4	none	none	none	negligible	none	none
Acrylic Fibers	6	none	none	none	unlikely	none	none
Pharmaceuticals							
Biological Products (SIC 2831)	304	none	none	none	none	none	none
Medicinals and Botanicals (SIC 2833)	179	likely ^a	likely	none	likely	none	none
Pharmaceutical Preparations (SIC 2834)	757	none	none	none	none	none	none
Paint and Allied Products (SIC 2851)	1,500	likely	likely	negligible	negligible	negligible	negligible
Organic Chemicals							
Lead Alkyls	6	possible	negligible	negligible	likely	negligible	none
Maleic Anhydride	10	none	none	none	likely	none	none
Methyl Methacrylate	4	none	none	none	likely	none	none
Toluene Diisocyanate	10	probable	possible	none	likely	none	none
Nitrobenzene	7	none	none	none	possible	none	none
Chlorobenzene	6	likely	possible	none	likely	none	none
Furfural	5	negligible	none	none	unlikely	none	none
Benzylchloride	4	negligible	none	none	possible	none	none
Epichlorohydrin	3	none	none	none	negligible	none	none

TABLE VI-14 (Continued)

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Organic Chemicals (Continued)							
Ethanolamines	5	none	none	none	likely	none	none
Fluoromethanes	10	none	none	none	negligible	none	none
Acrylonitrile	6	0	0	0.1-0.2%	0.4-0.9%	0.1-0.2%	none
Chloromethanes and Perchloroethylene	19	0	0	0.0-0.04	0.0-0.1	0.0-0.04	none
Ethylene Dichloride and Vinyl Chloride Monomer	20	0	0	0.0-0.03	0.0-0.1	0.0-0.03	none
Pesticides							
Active Ingredients (SIC 28694)	120	likely ^f	probable	negligible	likely	negligible	negligible
Formulators (Agricultural Chemicals, N.E.C.) (SIC 2879)	410	unlikely	unlikely	negligible	likely	negligible	none
Commercial Explosives							
High Explosives	15	possible	possible	none	likely	none	none
Blasting Agents-Explosives	80	possible	unlikely	none	likely	none	none
Petroleum Refining							
Small	162	unlikely	unlikely	none	likely	none	none
< 35 MB/D ^g							
Medium	66	negligible	negligible	none	likely	none	none
35-99 MB/D							
Large	57	none	none	none	likely	none	none
> 100 MB/D	23	likely	likely	possible	likely	possible	none
Petroleum Rerefining (SIC 2992)							
Rubber Products	210	probable	probable	none	negligible	none	none
Tires and Inner Tubes (SIC 3011)							
Other Rubber Products (SIC 3021, 3031, 3041, 3069)	1,500	negligible	negligible	none	negligible	none	none

TABLE VI-14 (Continued)

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Leather Tanning and Finishing							
Chrome Tan	83	0	0	0 ^h	none	none	none
Nonchrome Tan	16	3	200	175,300	none	none	none
Retan(sides/splits)	37	0	0	0	none	none	none
No Beamhouse	29	1	20	36,000	none ²	none	none
Through-the-blue	12	0	0	0	none	none	none
Shearling	9	0	0	0	none	none	none
Leather Finishers	85	0	0	0	none	none	none
Convertors, Brokers, Sales Offices, Dealers, etc.	159						
----- Not directly affected by RCRA requirements -----							
Ferrous Metal Smelting and Refining							
Iron and Steel (SIC 3312)	152	negligible	negligible	negligible	likely	negligible	negligible
Ferroalloys (SIC 3313)	28	possible	possible	possible	likely	possible	possible
Ferrous Foundries (SIC 332)	1,700	possible	possible	possible	likely	possible	none
Nonferrous Metal Smelting and Refining							
Primary Aluminum	31	unlikely	0	4,500 MT	+0.13%	-0.10%	\$6.8 million
Primary Lead	7	0	0	1,800 MT	+0.15	-0.3	1.5 million
Primary Copper	16	0	0	900 MT	negligible	<0.05	1.0 million
Primary Zinc	6	possible	possible	3,600 MT	+0.4	-0.86	4.3 million
Secondary Lead	80	unlikely	0	900 MT	+0.1	-0.15	1.0 million
Secondary Copper	35	0	0	0	<0.1	<0.05	0
Secondary Aluminum	93	0	0	<900 MT	negligible	0	0
Tungsten	4	0	0	0	<0.1	0	0
Mercury	1	0	0	0	<0.1	0	0
Electroplating and Metal Finishing							
Job Shops	2,940	48	1,340	\$49.0 million	6.6% ^j	none	none
Captives	6,077	none	none	none	<1.6 ^h	none	none
Special Machinery							
Special Industry Machinery (SIC 355)	2,700	unlikely	unlikely	none	likely	none	none
Office, Computing, and Accounting Machines (SIC 357)	400	unlikely ^j	unlikely	negligible	likely	none	negligible

TABLE VI-14 (Continued)

Industry Segment	Number of Existing Plants in 1978	Plant Closures	Job Losses	U.S. Production Cutbacks	Price Increases	U.S. Demand Reduction	Balance of Payments Effects
Electronic Components (SIC 367) ^k	4,500	possible	possible	unlikely	probable	negligible	unlikely
Battery Manufacturing							
Storage Batteries (SIC 3691)	207	possible	possible	none	likely	none	none
Primary Batteries (SIC 3692)	56	none	none	none	likely	none	none
Drum Reconditioning (SIC 5085)	200	none	none	none	likely	none	none
Chemical Wholesaling (SIC 5161)	3,400	none	none	none	likely	none	none

a. Thousand metric tons.

b. 1) = small plant

2) = medium-sized plant

3) = large plant

4) = extra large plant

c. Only six diaphragm-process plants are subject to the regulations, two plants in each size category. Because of the small number of plants experiencing an impact, the size of the category-wide price impacts is small or insignificant.

d. Some, possibly most, of these chlorine operations are part of larger industrial installations. This reduces the possibility that all of these plants will actually close.

e. Some of these closures will be process unit shutdowns rather than whole plants.

f. Mainly process units rather than plants.

g. MB/D = Thousands of barrels per day.

h. Cattlehide equivalents.

i. Will be passed through to final product.

j. This estimate assumes that no substantial capital costs will be required to modify the equipment used to manufacture printed circuit boards and semiconductor chips.

k. A few plants in the industry that handle specialized products utilizing hazardous materials or processes may close as a result of adverse cost impact.

Source: Arthur D. Little, Inc., estimates.

Significant plant closures, job losses, and price increases will occur in segments of the inorganic chemical, textile manufacturing, leather tanning and finishing, nonferrous metal smelting and refining, and electroplating and metal finishing industries. Within textile manufacturing, the largest number of job losses, about 1370, is expected in the knit hosiery segment where 6 plants are expected to close. Two primary zinc plant closures in the nonferrous metal smelting and refining industry could result in 1200 job losses. Forty-eight job shop closures in the electroplating and metal finishing industry are expected to result in roughly 1340 job losses.

The economic impact results for the six high-impact industries are based on an earlier set of compliance costs, generally smaller than those reported here. The compliance cost estimates used for these six industries are slightly higher than the earlier version, except for the electroplating industry. In that case, the final cost estimates are approximately twice as high as the previous data. Time considerations prevented preparing a revised set of quantitative impact estimates.

VII. LIMITS OF THE ANALYSIS

A. INTRODUCTION

The limitations of the analysis presented in this report are in three categories: data availability, analysis methodology, and topics covered. This chapter summarizes the major limitations in these areas.

The chapter is intended to assist in interpreting the results of the analysis. An analysis of this type is always constrained in some respects by data availability, time, and budget. The summary of the major limitations does not mean that the conclusions are invalid or are compromised. The project has been a major undertaking by EPA, and its results provide information on hazardous waste generation and waste management practices, costs of compliance with RCRA ISS, and the economic impacts of the regulations.

The analysis is comprehensive and complex. Of necessity it contains many simplifying assumptions, and has had to draw conclusions from limited data. In many cases, further refinement of details would not change the conclusions significantly. In general, the assumptions made are intended to portray "most likely" cases. When the most likely or reasonable assumption is not evident, conservative, i.e., more costly, assumptions were used. The occasional use of conservative assumptions is intended to avoid inadvertently masking from decision makers and the public the economic consequences of the regulations to the regulated industries.

B. DATA AVAILABILITY LIMITATIONS

The underlying data base on hazardous waste generation and waste disposal comes primarily from the series of hazardous waste assessment reports EPA contractors prepared between 1973 and 1976.* Where more current data were available, they were used to revise the waste generation estimates. But a significant new body of field data on waste generation and waste disposal practices was not developed for this analysis. Development of new field data would establish a firmer basis for EPA's conclusions on waste hazard potential, identify changes in industry practice, use more consistent analysis methodologies across industries, and fill gaps in the existing data. Independent reviews of the waste quantity estimates developed for this analysis concluded that the estimates are the best available, given the current data base.** Differences between the waste quantity data base and actual waste generation in 1980 result primarily from incomplete or inaccurate surveys during the assessment studies; changed definitions of hazardous waste; changed industry practice, which has probably reduced the waste quantities; and the exclusion from the analyses of some industry segments or of some waste streams (such as solvents).

*See list at end of Chapter IV.

**Putnam, Hayes & Bartlett, Inc., "Industrial Hazardous Waste Generation," Draft Report to U.S. EPA, Office of Planning and Evaluation, Economic Analysis Division, October 1980.

The assessment reports include information on such categories of waste disposal practice as sanitary landfills, dumps, surface impoundments, and incinerators, but little or no information on whether waste is disposed of at the plant (on site) or at commercial facilities (off site), or on the prevalence of training for waste management personnel, recordkeeping, security, or other practices called for in the RCRA ISS regulations. For this analysis, assumptions were made about current industry practices in these areas; these assumed practices were used as the baseline from which to calculate incremental costs of compliance.

In the leather tanning and finishing industry and in some product categories of the organic chemical industry, the waste disposal practice data collected for this project included information on off-site disposal practices. For other industries, no reliable information is available on the use of commercial disposal facilities. The cost analyses for these other industries included the assumption that plants with waste generation rates below a volume breakpoint specified for each disposal technology would ship their hazardous waste off site. The use of breakpoint values is based on the economic rationale that disposal at off-site commercial facilities becomes less expensive than on-site disposal the lower the rate of waste generation. The primary reasons a plant would not follow the least-cost rationale are: limitations to on-site disposal, as in urban areas; or conversely, a desire to maintain control of the waste and therefore not ship it off site. The weight of these factors is not known for the industries studied. The total cost conclusions do not change significantly if the cut-off rates for off-site disposal are changed by $\pm 50\%$, as demonstrated in the sensitivity analysis in Chapter VI.

The presence of a surface impoundment at a plant site results in major ISS compliance costs. The EPA's Surface Impoundment Assessment data base has provided reasonable estimates of the total number of impoundments per industry and their acreage.* The distribution of these impoundments by plant size is not readily available, however. When possible, assumptions about the distribution of impoundments by plant size were based on a review of actual plants and knowledge of the industries. In general, impoundments are assumed to be used by plants of all sizes, with the acreage of individual impoundments directly related to plant production. The assumed use of surface impoundments is incorporated in the model plant specification.

The closure costs for a surface impoundment can have a significant cost impact on a small plant. The economic impacts of the regulations would be higher than those estimated in this report if more smaller plants actually use impoundments than have been assumed, although the total compliance costs per industry would not be different.

The model plants for manufacturing industries were constructed by assuming that production and waste generation are linearly related to employment within an industry segment. Analysis of production and employment in manufacturing industries has shown such correlation. The difference in production per employee

*Surface Impoundment Assessment Comprehensive Listing (June 1980). Unpublished data from U.S. EPA, Office of Drinking Water.

the use of waste disposal technologies, such as sanitary landfills, in 1976, prior to RCRA's enactment, is assumed to have continued to the present and to continue through the enforcement of the ISS. Actual changes in off-site disposal and disposal technology usage that have already taken place were not incorporated in the analysis. The assumption fixing the pattern of on-site and off-site disposal and the use of 1976 disposal technologies is necessary because the actual changes in disposal practices (on-site or off-site) are not known. Companies are not expected to make large investments in upgrading waste management until the final technical permitting regulations are published.

The ISS will increase the cost of providing commercial disposal services. These costs have been translated into price changes by assuming that past expectations of returns on invested capital will continue and that the prices for disposal services will increase in proportion to the higher cost of providing the service as a result of RCRA. This price change approach is static, rather than the more likely dynamic price behavior arising from regional supply and demand patterns. The incremental disposal prices assumed in the analysis are representative of long-term price changes as waste disposal supply and demand come into balance at industry-average profitability levels. If there are significant shortages of disposal capacity, prices will be higher than estimated. Shortages would result from a movement of waste from on-site to off-site disposal or from closing existing off-site facilities with high contamination potential. Local opposition to building hazardous waste disposal sites will restrain capacity expansion. Doubling the prices for off-site disposal would increase the annualized compliance cost for all industries by only about 6% as shown by the sensitivity analysis. The highest cost impact would be on plants shipping small quantities of waste to off-site disposal.

No incremental transportation costs to generators sending wastes off site were assumed. Small costs due to manifest handling by transporters were not included in the cost calculation program. Shifts in disposal practices caused by changes in demand on TSDFs or by closure of TSDFs operating under pre-RCRA rules could induce significant incremental costs if the mean distances between generator and TSDF increase. The omission of incremental transportation costs is consistent with the ISS assumption of no change in waste management practice. In the next round of analysis, provision for added transportation costs should be included in the economic impact of the permanent TSDF regulations to be promulgated.

The incremental cost analysis spans the period from approximately 1976 to the time the promulgated ISS regulations are enforced. In 1980, many of the larger waste generators had already changed their disposal practices in anticipation of RCRA and as a result of state requirements also enacted in anticipation of RCRA. Moreover, the commercial disposal fees generators pay also reflect RCRA-anticipated costs. The implication is that technically sophisticated companies and those attuned to impending regulations have already incurred some RCRA compliance costs. The new compliance costs for these plants after 1980 will be less than projected. The large number of smaller and less sophisticated plants will bear the compliance costs after promulgation and enforcement.

between the largest and smallest plants is usually less than 10%. In the process industries, such as commodity chemicals where this assumption would not be valid, actual production or capacity data were used. There are no data on differences in waste generation per unit of production between large and small plants, and a uniform ratio was used across all plant sizes within an industry segment or sub-segment with common production technology. The errors introduced into model plant incremental compliance costs by this assumption should not be significant because individual plant costs are not strongly dependent on waste volume.

The value added and the production value were also assumed to be linearly related to employment, except where actual production levels or capacity for the process industries were known. Data for value added are known for 4-digit SIC codes only; therefore, these ratios were used to estimate value added for industry segments smaller than the 4-digit SIC code level. The deviation of value added from the assumed linear relationship could result in errors of unknown, but almost certainly small, magnitude.

C. ANALYSIS METHODOLOGY LIMITATIONS

The major methodological limitations are in four areas: the use of model plants, the use of a static waste management practice scenario, the ambiguous difference between pre-RCRA and post-RCRA expenditures for hazardous waste management, and the use of qualitative and judgmental approaches to economic impact analysis.

Model plants were constructed for each industry segment to represent groups of plants with similar compliance costs and economic constraints. Differences in size (large, medium, small, and small waste generator) and major differences in waste generation and waste management practices are reflected in the model plants. The use or non-use of surface impoundments and the presence of plants in states with or without RCRA-like regulations are examples of differences in waste management practices. Disaggregating the total population of plants in an industry into model plant groups highlights the range of costs and economic impacts most individual plants will experience as a result of the regulations. Nevertheless, a model plant is inherently an average of a number of real plants that in actuality can differ from one another in technical or economic respects. The use of such average model plants obscures to a degree the economic impacts on a plant that experiences costs higher than the average represented by the model, or plants in a weaker economic position than the model. These vulnerable plants can therefore be hidden from the regulator when weighing the consequences of the regulations. In developing the economic impact conclusions for an industry, the analysis considered the potential for higher-than-average costs. It is difficult, however, in the absence of more complete field-based information, to go far beyond the conclusions drawn directly from the model plant data.

A static waste management practice scenario was used in the cost analysis. The analysis is based on the assumption that under the ISS all waste disposal currently performed at the plant site would continue to be performed at the plant, independent of changes in the relative cost of on-site and off-site disposal. Moreover,

For plants with little or no hazardous waste prior to the enforcement of the water regulations, the baseline hazardous waste disposal costs attributable to FWPCA can be greater than the additional costs attributable to ISS. In these cases, the economic impacts from FWPCA sludge disposal costs are more important than the ISS impacts reported here. The most severely affected plants are those currently discharging their wastewater with hazardous waste in suspension to municipal sewage systems. These plants will install pretreatment equipment at the same time RCRA is increasing the cost of off-site sludge disposal. Paint manufacturers are an example.

The economic impacts that would be identified by considering the RCRA and FWPCA costs simultaneously would be higher than the sum of the impacts from the costs considered separately. The likelihood of plant closures, for example, increases faster than compliance costs. Therefore, the economic impacts reported for RCRA are an understatement of the total impact of the combined RCRA and water regulations. Moreover, the impacts understate the added impact of RCRA if the cost of the water regulations had been considered in the same time frame.

Figure VII-2 outlines the configuration of a typical plant generating hazardous waste both prior to RCRA's enactment and after the promulgation of RCRA and FWPCA regulations. The application of the respective regulations to the waste treatment and disposal activities at the plant are identified.

Hazardous waste treatment, such as dewatering prior to disposal, may not be adequately accounted for in either the RCRA or FWPCA cost analysis. The waste volumes reported in Chapter IV and used in the ISS cost analysis are in a dewatered state suitable for disposal in the assigned technology (wastes to surface impoundments are not dewatered). Many of these wastes will have undergone more pre-disposal treatment in order to reduce their volume or make them nonflowing than was the case in 1976 or than is necessary to comply with the water regulations. The cost of this treatment has not been included in the ISS cost analysis and may not be included in the FWPCA cost analysis.

Another problem of understated economic impacts as a result of additive compliance costs occurs in the smelting and refining industries. The economic impacts from the ISS for copper smelting, for example, were evaluated separately from any potential RCRA cost for copper mining even though many mining and smelting operations are integrated. The company operating the mine and smelter will consider the economic viability of the entire complex in response to the combined cost.

The economic impact conclusions are essentially long run in nature, since annualized costs were used as the principal measure of financial burden. This treatment understates potential short-run impacts on individual firms hard-pressed to meet the high first-year costs imposed by the ISS regulations. This potential problem would be exacerbated by imposing financial requirements with high front-end loading, such as a one-year or five-year trust fund pay-in period.

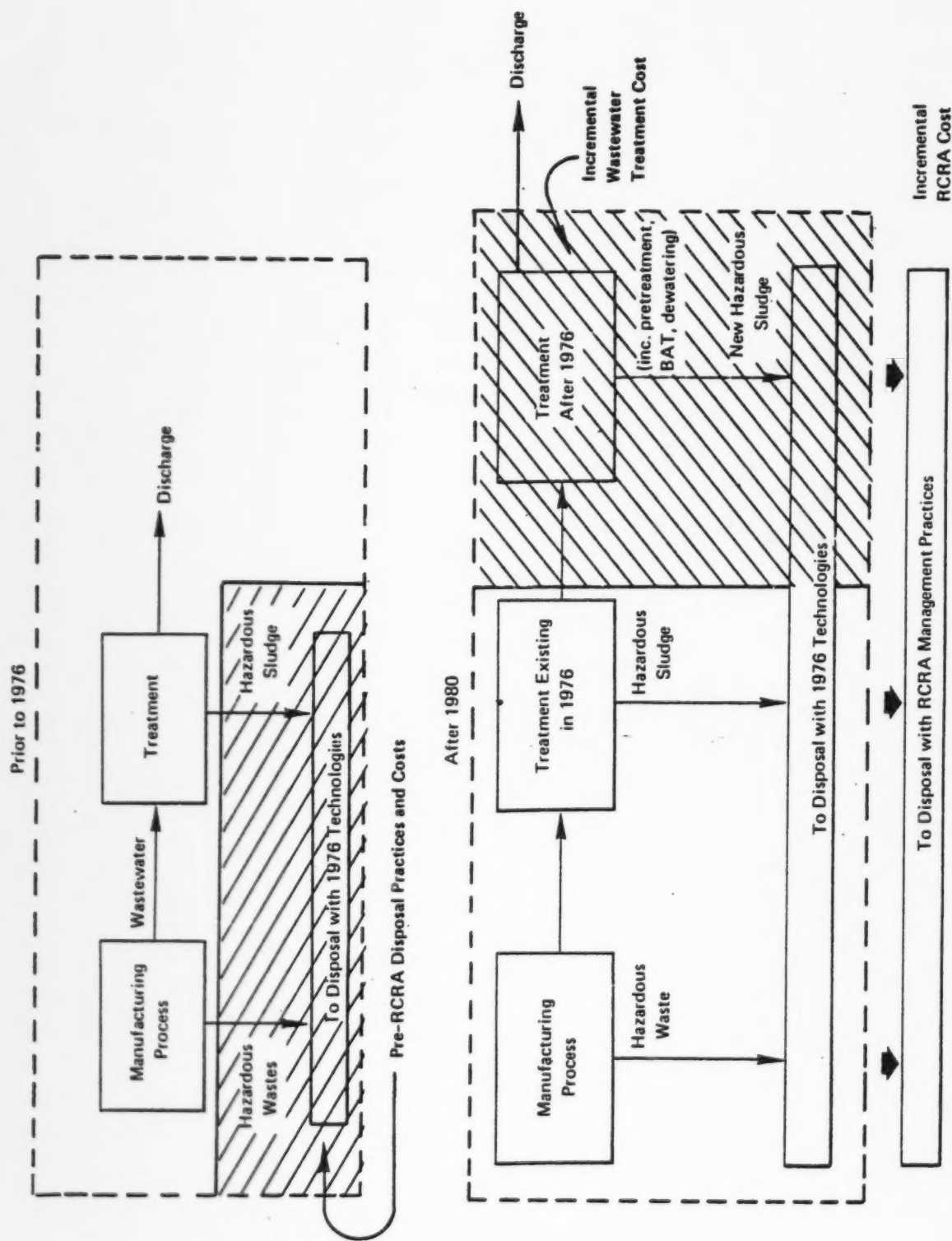
Incremental costs are defined as the costs hazardous waste generators will incur for waste management as a result of RCRA beyond what they were spending for waste management prior to the enactment of RCRA in 1976. The incremental costs are somewhat ambiguous because plants in some industries are already making a portion of the expenditures, as noted above, and because the distinction between RCRA costs and wastewater treatment costs is subtle. The incremental costs attributed to the ISS are additive to expenditures attributed to generators for wastewater treatment. For some industries, pretreatment standards and best available technology economically achievable (BATEA) effluent guidelines will be promulgated, based on the Federal Water Pollution Control Act (FWPCA), and enforced during the same time frame as RCRA. Industries producing new or additional hazardous sludges after 1980 as a result of the FWPCA wastewater treatment requirements will have incremental hazardous waste disposal compliance costs from both the water regulations and RCRA. Where estimates of wastewater treatment sludge volumes to be newly generated after 1980 are available, these volumes were included in the ISS cost analysis.

The relationship between baseline and incremental RCRA and FWPCA compliance costs is illustrated in Figure VII-1. Hazardous sludge generated for the first time after 1980 as a result of the water regulations will have a pre-RCRA baseline hazardous waste disposal cost equivalent to the pre-1976 baseline costs for other hazardous sludge. This cost is attributed to the BATEA or pretreatment regulation. In addition, the post-1980 wastes will have incremental ISS costs that are attributed to RCRA in this analysis. In practice the waste generator experiences one cost increase, not two, and suffers economic impacts from the combination of FWPCA and RCRA.

WASTE CATEGORIES	COST CATEGORIES	
	Waste Treatment/Disposal Practices	
	Pre-RCRA (1976)	Post-RCRA
Pre-RCRA (1976) • Process Waste • BPT Sludges	Baseline RCRA Cost	Incremental RCRA Cost
Post-RCRA • BAT Sludges • Pretreatment Sludges	Baseline RCRA Cost Incremental Wastewater Treatment Cost	Incremental RCRA Cost

Source: Arthur D. Little, Inc.

FIGURE VII-1 HAZARDOUS WASTE TREATMENT AND DISPOSAL COST CATEGORIES



Source: Arthur D. Little, Inc.

FIGURE VII-2 INCREMENTAL RCRA COMPLIANCE COSTS

The economic impact analyses for some industries and product groups use economic and financial models to develop quantitative conclusions for plant closures and other measures of economic impact. These industries were selected by EPA early in the project as potentially facing high economic impact from the regulations, but the impact expectations have not been entirely borne out. On the other hand, some industries treated qualitatively now appear to face high economic impacts. It would not have been possible, or even necessary, to analyze all industries in depth. Nevertheless, a different mix of quantitative and qualitative treatment of the industries would probably have been undertaken had the current impact conclusions been known earlier.

D. LIMITATIONS TO THE TOPICS ANALYZED

The focus of the cost and economic analysis is on industrial plants and service facilities producing hazardous wastes. All generators, storers, treaters, transporters, and disposers of hazardous waste that will be governed by the ISS were not included in the economic impact analysis. Waste generators were the focus of the analysis and are the mechanism through which some other participants are brought into the analysis. Companies in the business of hazardous waste transportation or of hazardous waste processing and disposal are not separately evaluated for their economic impacts, although they are directly regulated by RCRA Subtitle C. Changes in fees charged by these firms for commercial hazardous waste disposal as a result of the ISS are included in the analysis because they are higher costs to the waste generators.

The waste-generating plants included in this report are responsible for a significant percentage of the waste currently classified as hazardous by EPA that is produced by all plants in the United States. Excluded from this analysis are important amounts of waste produced by government facilities, the military, such large manufacturing facilities as aircraft and automobile manufacturers (except for captive electroplating shops, which are assessed), and numerous service businesses. The costs and impacts projected in this report are borne only by plants in the 22 industries analyzed and not by all waste-generating industries. Chapter IV discusses the inclusiveness of the total waste coverage.

Not all hazardous waste generating plants in the 22 industries were included in the cost analysis. The most limited coverage is for the organic and inorganic chemical industries. This limitation is important because of the association in the mind of the public between hazardous waste and the chemical industry. Only the waste resulting from 20% of the production volume of organic chemicals is included. Coverage of inorganics is somewhat more complete, and some important segments of these industries do not produce large volumes of hazardous waste. The coverage reflects the limited scope of the EPA assessment reports of 1973-1976 rather than recent EPA decisions to exclude wastes from these industries from regulation. EPA has covered some of the missing waste streams in its listing of generic wastes.

The analysis excludes certain high-volume wastes whose toxicity has not been determined. The volumes of these wastes are orders of magnitude greater than the

volumes of waste included in the cost analysis. Either the EPA has postponed the regulation of these wastes, e.g., oil and gas drilling muds and brines and fly ash from coal-burning utilities, or coverage by the regulations is so uncertain that their inclusion would distort the results reported here. The pulp and paper industry, phosphate mining, metal mining, and cement production fall in the latter category.

Only a part of the disposal practices subject to the ISS regulations were included. Tanks, surface impoundments, land treatment, landfills, and incinerators are included in the analysis; containers, waste piles, chemical treatment, thermal destruction, deep well injection and resource recovery are not. Some of these practices, such as thermal destruction, are employed only in very limited application; others, such as deep well injection, have no ISS incremental costs.

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Many individuals contributed to the report. The EPA staff who guided the work and the Arthur D. Little staff who participated in the project are listed below. Other contractors to EPA whose work results are included in the report are also listed.

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